POWER

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Licensing Engineers

BEFORE the professional engineers got active and secured the passage of legislation licensing them to practice as doctors and lawyers are licensed, their practical operating fellows had been agitating for years and had in several states and cities obtained legislation requiring a man to be examined and licensed before he is allowed to take responsible charge of a boiler or a steam plant.

There is likely to be confusion as to how far the law for professional engineers reaches into the practical operation of a power plant and to what extent the law for the operating man applies to those who, while broadly responsible for the operation of the plant, function in executive rather than operative capacities.

The registration of engineers upon whose work land titles, the safety of dams, bridges and other public structures is dependent is easy to justify. The services of many other engineers, just as professionally qualified, is charged with less public interest.

The New York State law for licensing or registration of professional engineers defines professional engineering as follows:

> A person practices professional engineering within the meaning and intent of this article who holds himself out as able to do, or who does, the work that an engineer does in the planning, designing, constructing, inspecting and supervising of engineering work, or appliances involved in public or private projects, or in making investigations for proposed engineering projects.

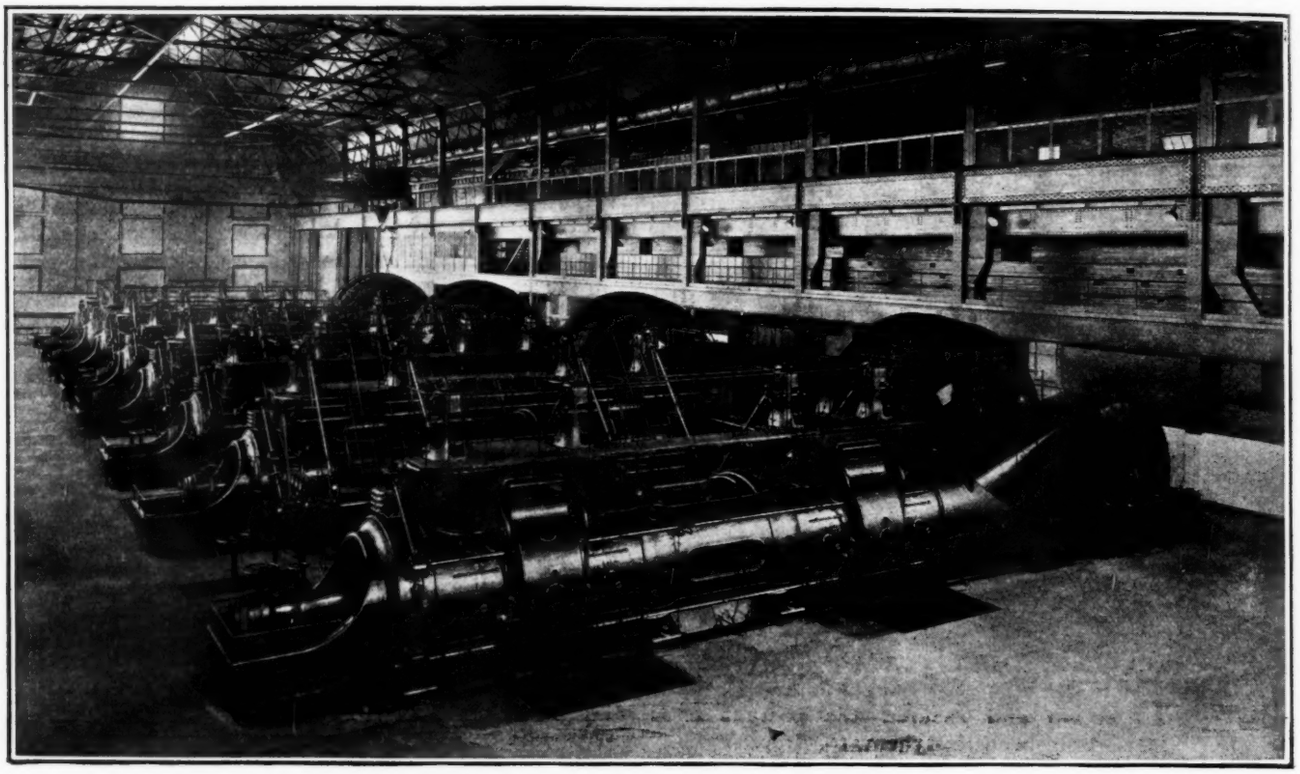
New York State has no law for the licensing of firemen and those in charge of steam plants, but a number of municipalities in that and other states have such requirements.

Some of the desk men related to power-plant management take out the practical men's licenses and some do not.

Some of the big men are satisfied to have their subordinates examined as to their fitness for the work that they are expected to do and to permit them to exercise their responsibility for it under the law; some concerns try to cover the law with a blanket license to one responsible man.

All who think that they may come under the professional law are advised to send in their applications for registration, with the assurance that, should registration in their case not be required, the fee will be returned.

F. R. Low



Illinois steel blast-furnace gas engines

New Gas-Engine Plant of the Illinois Steel Company

Plant contains four blast-furnace twin-tandem gas-engine units, each rated at 3,300 kw., but with overload capacity exceeding 25 per cent. With these engines the thermal efficiency increases with the load. The average economy maintained in practice approximates 24 per cent.

ABOUT two years ago the first unit of a large blast-furnace gas-engine plant at the South Works of the Illinois Steel Co. was ready for service. Since that time three other units have been installed, and in the new building erected for this plant there is still space for two more units and for two steam turbo-generators should these machines be deemed necessary to carry momentary peaks of the daily load. This new plant, known as Power Station No. 1, operating in parallel with the other gas-engine and steam plants at the works, supplies current to the motor-driven mills and to a large cement plant at Buffington, about seven miles distant. It was installed to replace a steam plant that was becoming antiquated and lacking in capacity. The blast-furnace gas supplemented by coal had been burned under boilers. This gas is now used direct in gas engines at three times the economy, that is, at a thermal efficiency averaging close to 24 per cent for the twenty-four hours in a day, as compared to 8 per cent for the steam plant.

As a rule gas engines in steel plants have a comparatively high load and use factor, and if the service is continuous the prime movers are called upon to deliver power at a fairly constant rate. At times, however, momentary heavy overloads must be dealt with, and gas engines being limited as to overloads, were often taxed beyond their maximum capacity. To meet this difficulty there were two solutions open: One was to use steam turbines to carry the peak load, leaving the constant load to the gas engines, and the other was to install gas engines of improved design having large overload capacity.

To do this various methods had been tried with different degrees of success, European engineers especially, working on the plan of supercharging to increase the air gas contents of the cylinder to a pressure above atmospheric. This method has been found satisfactory as to overload capacity, although it does not give greater economy at the increased load. The objection to the supercharging system is the difficulty in controlling both air and gas at increased pressures.

Another method, and that employed in the engines selected for the plant, consists in increasing the B.t.u. content in the cylinder charge by means of a more efficient mixing mechanism and by changing the valve design and valve setting to secure better scavenging of the exhaust gases.

In engines designed fifteen years ago it was impossible to figure conservatively on a greater maximum mean effective pressure than 75 lb. per sq.in. and a

normal operating mean effective pressure of 65 lb. per sq.in., when using gas of about 93 B.t.u. per cu.ft., which is the heat content of the gas available for the present plant. With the engines installed, it is possible to figure on a continuous mean effective pressure of 85 lb. per sq.in., which means a correspondingly high thermal efficiency, as indicated in the economy curves, Fig. 2, drawn up for these engines. It will be noticed that the efficiency increases with the load to a maximum approaching 30 per cent. No official tests have been conducted in the plant, but the results obtained approximate the possibilities indicated in the curves.

Each of the four units installed have been rated conservatively at 3,660 kva., or in round numbers, 3,300 kw. at 90 per cent power factor, giving an aggregate nominal capacity of 13,200 kw. for the plant. In operation the engines have demonstrated their ability to carry considerable overload. For the most part they have been operated over rating, the average load on the four units for twenty-four hours approximating 13,500 kw., but hourly averages of 3,800 kw. per unit have been maintained and the machines have demonstrated that they will carry nicely loads in excess of 4,000 kw. with 93 B.t.u. gas.

Each unit consists of a four-cylinder twin-tandem gas engine, having cylinders 48 in. diameter and 60 in. stroke, directly connected to a 3,660 kva. 25-cycle 2,300-volt generator running at 83⅓ r.p.m. To give an indication of the size of these units, which are reported to be the largest gas engines in the country, each of the two frames per engine is a one-piece, open-top casting weighing 92 tons. The main journals are 32x54 in.; the crankpins, 21x19 in.; the crosshead pins, 16½x19 in.; the piston rods, 16 in. diameter, and the flywheel, which is 23 ft. diameter, weighs 150,000 lb. The general construction and arrangement of the valve gear is indicated in the longitudinal and transverse sections shown in Figs. 4 and 5.

An interesting feature is the mixing mechanism consisting of an annular chamber having controlled air ports on the outside and valve-controlled gas ports on the inside. The streams of gas and air coming in at high speed and from opposite directions, produce an intimate mixture which tends to reduce the usual air excess. The engine is governed on the mixture system, throttling being only for the purpose of increasing the speed of the gases at the mixing point. The governor is of the hydraulic relay type, acting upon the time and lift of the gas valve. It thus admits more or less gas to the engine cylinders and at the same time controls the speed of the incoming air by adjusting the air ports in the mixing chamber.

The indicator diagram, Fig. 3, taken from one of these engines, shows uniform distribution of the load over the cylinder end. It is possible to adjust the valve gear so that the variations in the mean effective pressure will not exceed 2 lb. The initial pressures are somewhat higher for the same mean effective pressure, and the exhaust temperatures are lower than formerly, which is to be expected on account of the greater thermal efficiency obtained. Exhaust-gas analyses show an almost total absence of carbon monoxide, indicating the proper mixture of gas and air and good combustion throughout the cylinders.

Ignition is of the make-and-break mechanical type using spark coils in series with lamps at 110 volts. There are three spark plugs to each cylinder, each plug having its own control lamp and coil, so that should a short-circuit occur in one plug, it does not affect the others. This arrangement has the further advantage that a short-circuit will immediately announce itself by a constant light being shown on the ignition board or if proper contacts are not made the lamp will be dark. Two 10-kw. motor-generator sets supply the current for ignition. One of these units is a spare. The motor is a 250-volt direct-current machine driving a 110-volt generator.

Gas for the engines is obtained from a group of six of the eleven 600-ton blast furnaces installed at the works. In heat content it ranges from 93 to 95

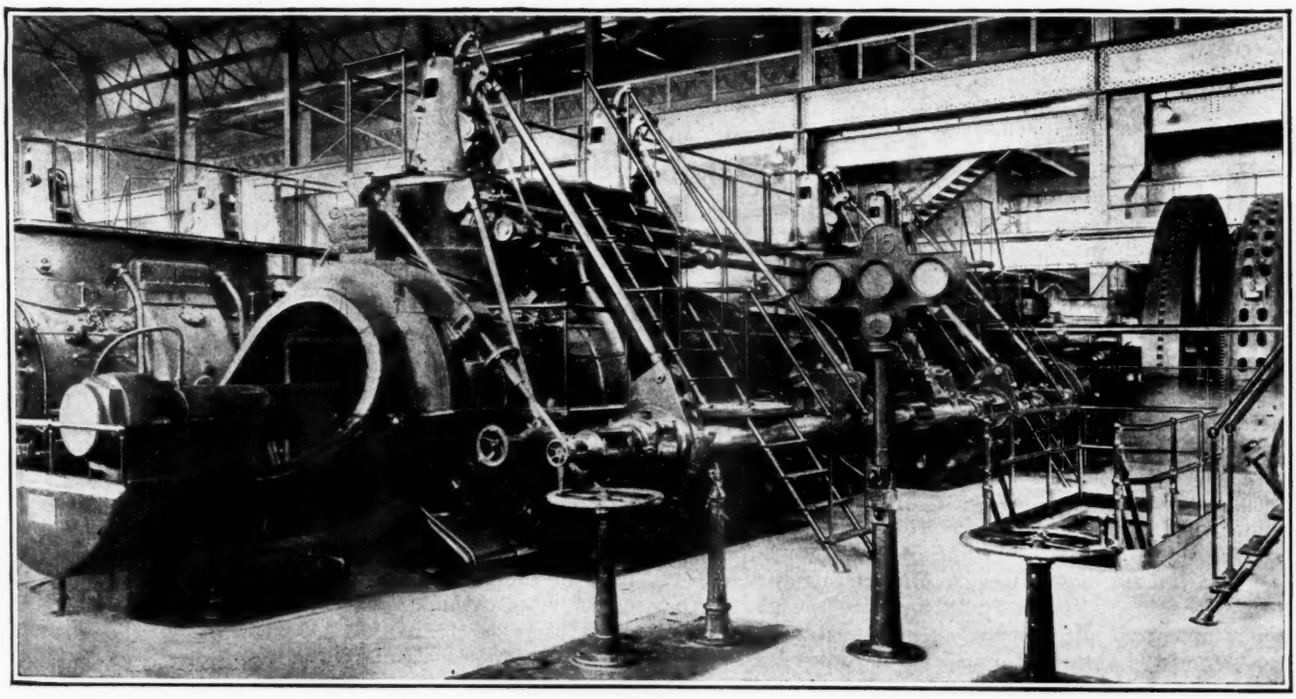


Fig. 1—Valve gear side of one-half of twin unit

B.t.u. per cubic foot. To clean the gas, it is first passed through primary washers at the blast furnaces and is then carried to the washer house containing four Theisen washers, each having a capacity of 15,000 cu.ft. per min. Three of the washers are driven by three-phase 2,200-volt induction motors, rated to deliver 200

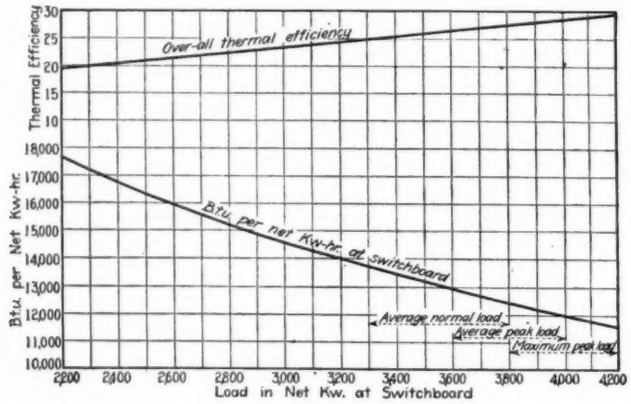


Fig. 2—Economy curves of twin-tandem gas-engine unit

hp. at a speed of 355 r.p.m. The fourth washer is a reserve emergency unit driven by a 150-hp. direct-current 40-deg. motor. Water for washing and for the plant as a whole, including the engine cooling water, totals 2,900,000 gal. a day.

From the washer building the gas passes to a holder having a capacity of 200,000 cu.ft. The supply is controlled automatically as the holder, in rising or falling in accordance with the engine demand, closes or opens a butterfly valve in the main connecting it with the washer house.

In the engine room a bank of colored lamps indicates the position of the holder. A white light indicates that it is in normal position, a green light that it is below the normal position, and a red light, top and bottom, shows that the holder is dangerously high or dangerously low. With the showing of either of these red lights a whistle blows to warn the operating force.

A flow meter is installed to measure the gas to the holder and a Venturi meter is provided between the holder and the engines for use when running a test on a specific unit. From the holder a gas main 7 ft. in diameter is carried the full length of the power-plant building, but exterior to it, on structural steel supports. From this main the gas intakes for each side of the twin units drop down to the basement level and pass up from below to the inlet valves of each cylinder. All intakes are protected by water seals to guard against gas leakage into the building, and the same precautions have been taken in the washer building on both sides of the washers. Exhaust pipes for each side of the twin units pass out through the wall and rise to the roof level to discharge to atmosphere. Between each pair of exhaust pipes is the hooded air intake for the unit.

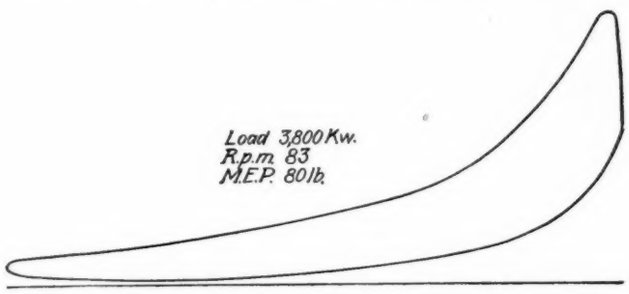


Fig. 3—Typical indicator diagram from gas engine

To utilize the waste heat in the exhaust gases from each engine, a special waste-heat boiler to generate steam at 200 lb. pressure has been designed by G. R. McDermott, assistant chief engineer of the company. Space is available and the boilers will be installed when the demand for steam and the economic conditions of the plant as a whole make it desirable. As previously outlined in a paper before the Association of Iron and Steel Electrical Engineers, this boiler is of the high-mass velocity, fire-tube, horizontal, single-pass type designed to utilize the waste gases at a temperature approximating 850 deg. F. Based on an average load of 3,000 kw., it is estimated that the boiler will develop 2.2 lb. of steam, net, per kilowatt generated at the switchboard. In other words, there should be sufficient heat in the exhaust from each unit to generate over 6,600 lb. of steam per hour at 200 lb. gage pressure. It is proposed to install independent superheaters in the exhaust mains leading to the boiler. These mains from each side of the engine pass from one end of the boiler to the other in opposite directions. A gas box

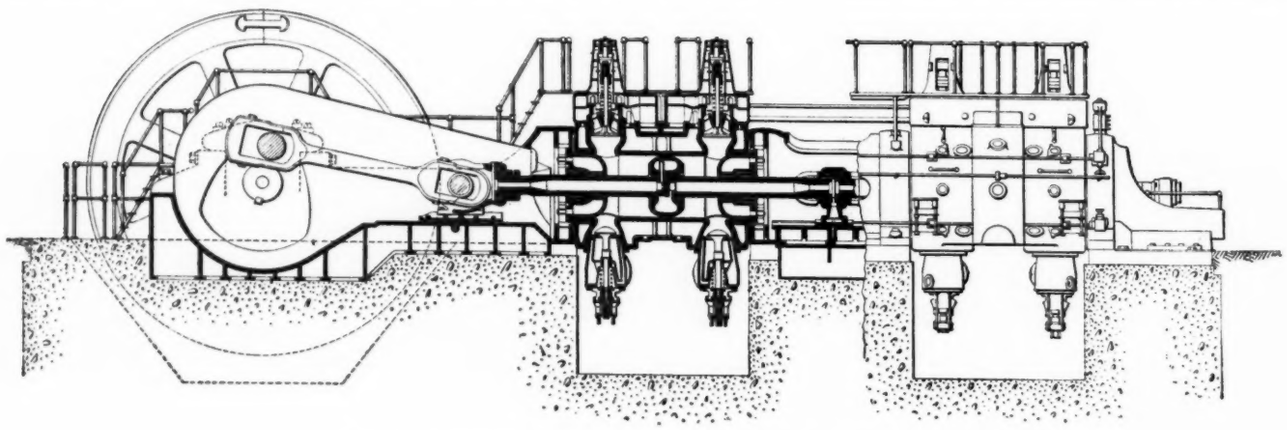


Fig. 4—Longitudinal elevation of engine in part section

at each end of the boiler will contain a vertical partition separating the incoming and outgoing gas. The boiler is to contain 476 flues, 1½ in. diameter and 12 ft. long, giving a total heating surface approximating 1,950 sq.ft.

Considering a total station load of 18,000 kw. for six units and 2.2 lb. of high-pressure superheated steam

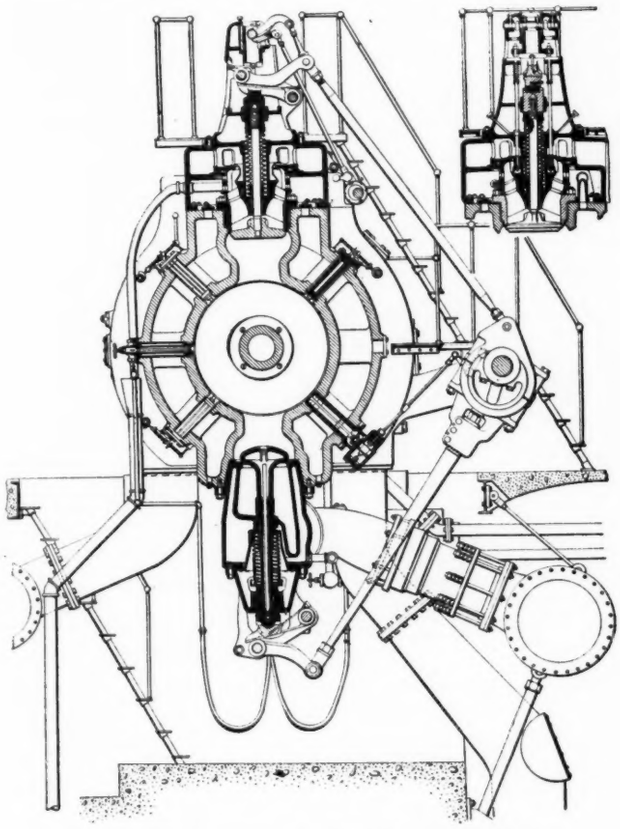


Fig. 5—Transverse section through cylinder

per kilowatt developed by the waste-heat boilers, there should be sufficient waste steam available to develop at least 2,640 kw. in a turbo-generator. This would add 440 kw. to the capacity of each unit and improve considerably the over-all thermal efficiency of the engines.

Starting is accomplished by means of air compressed to 200 lb. pressure. It is stored in eight tanks located in the basement supplying in common the four engines and with capacity for the two additional units previously mentioned. Two motor-driven compressors, each having a capacity of 300 cu.ft. of free air per minute, automatically maintain the pressure.

Lubricating engine oil for the generating units is purified by an individual gravity filtering system for each machine, with a capacity of 500 to 1,000 gal. an hour. As it comes from the engines, the oil has a temperature of about 120 deg. F. In the filter its temperature is raised to 180 deg. by exhaust steam from the pumps circulating the oil to the engine bearings. At this temperature the dirt and water drop out more readily. To reduce the temperature before returning the oil to the engines, it is pumped through a multi-whirl cooler of standard design, which reduces the temperature to 100 deg. F.

To circulate the oil there are two steam-driven pumps for each unit, one a spare which will start up automatically upon failure of the operating pump. This is accomplished by a home-made automatic control consisting of a pump governor at the center of a rectangular system of piping, with a valve on either side of the supply line to the governor and a valve on either side in the discharge line. The upper side of the diaphragm of the pump governor is connected to the oil pressure line going to the engine. If this oil pressure fails for any reason, the pump governor opens, letting the steam go to the other pump, which will immediately begin to operate and build up the oil pressure to normal. Steam pressure on the pump first in use is shut off by the operator.

In addition to the filtering units one oil separator of the portable centrifugal type has been provided. Periodically, the oil used in each unit is passed through this purifier. Cylinder oil is supplied from a central storage tank under air pressure to force-feed lubricators at the engines.

In the electrical department of the plant standard construction has been employed. The layout is good and was planned to work up from generator to feeder circuits to the height needed for the overhead transmission lines distributing the energy about the works at 2,200 volts. All the electrical equipment has been arranged in an alcove at the side of the main building. The generator switches are on a level with the engine-room floor. The bus structures are on the first balcony, and immediately above on the second balcony are the feeder switches.

To minimize the amount of cable in the generator pit the generator leads are brought out at an angle of 45 deg. instead of 90 deg., passing through the generator foundation and also the foundations for the building columns. This provides a straight run for the cable racks and eliminates the necessity of going around the main pilasters along the side of the engine room.

Fig. 6—Operating room showing benchboard and switchboard

A double-bus system has been employed. The buses are fully inclosed in concrete structures with Transite board doors. On the same floor—that is, the first balcony—is the operating room in which are the control and instrument boards. The generators are controlled from a radial benchboard with the instruments on vertical panels above, while the feeder switches and instruments are on a vertical board at the opposite side of the room. All the control wiring from the generator oil switches and field rheostats is carried through ducts into the bottom of the benchboard, while the feeder

switch control wiring is carried through ducts in the floor of the second balcony and down behind a false wall to the feeder switchboard on the first balcony. In this way the ducts are concealed but accessible through removable slabs.

One of the features of the control is the signal system of colored lights for starting and stopping. A red light calls for an immediate stop, and white lights on either side signal for normal starting or stopping. These lights are duplicated on a pedestal near the engine and are used principally to designate the unit in question. A solenoid-operated whistle controlled from a push-button on the benchboard calls attention to the signals. Another feature is the push-button motor control of the engine governors used when synchronizing a unit to bring it in on the line.

The entire switchboard layout has been planned for eighteen units to take care of the six gas engines and the two turbine-generators, for which the present building has been designed, a possible extension to include four more gas engines, the control of four old engine units in another plant, and the two high-tension circuits going out to the cement plant at Buffington. The layout calls for twenty-eight feeder circuits, of which ten have been installed. A feature in connection with the distribution is the standardization of feeder oil switch cell structures so that either the 1,500- or the 3,000-amp. switches in use will fit in any cell.

For excitation two 250-kw. 250-volt induction-motor-driven exciters have been provided, and there is space for a third unit of the same size. The exciter bus is carried the full length of the basement under the alcove, and the field rheostats and generator field switches are in this basement, opposite each unit. The rheostats are motor-driven under remote control from the benchboard. For emergency excitation a storage battery in one of the older plants is available.

Over all, the present building measures 375 ft. in length and the width is 115 ft. It is a brick and steel structure with concrete foundation and corrugated metal roof lined inside with wood sheathing to prevent condensation. The height from the engine-room floor to the roof girders is 51 ft. 7 in., and the headroom in the basement is 13 ft. 6 in. The foundations for the generating units are isolated and rest on piling, as do the main foundations for the building and the gas holder. A wainscoting of white enamel brick 6 ft. high and a red concrete floor decorate the interior.

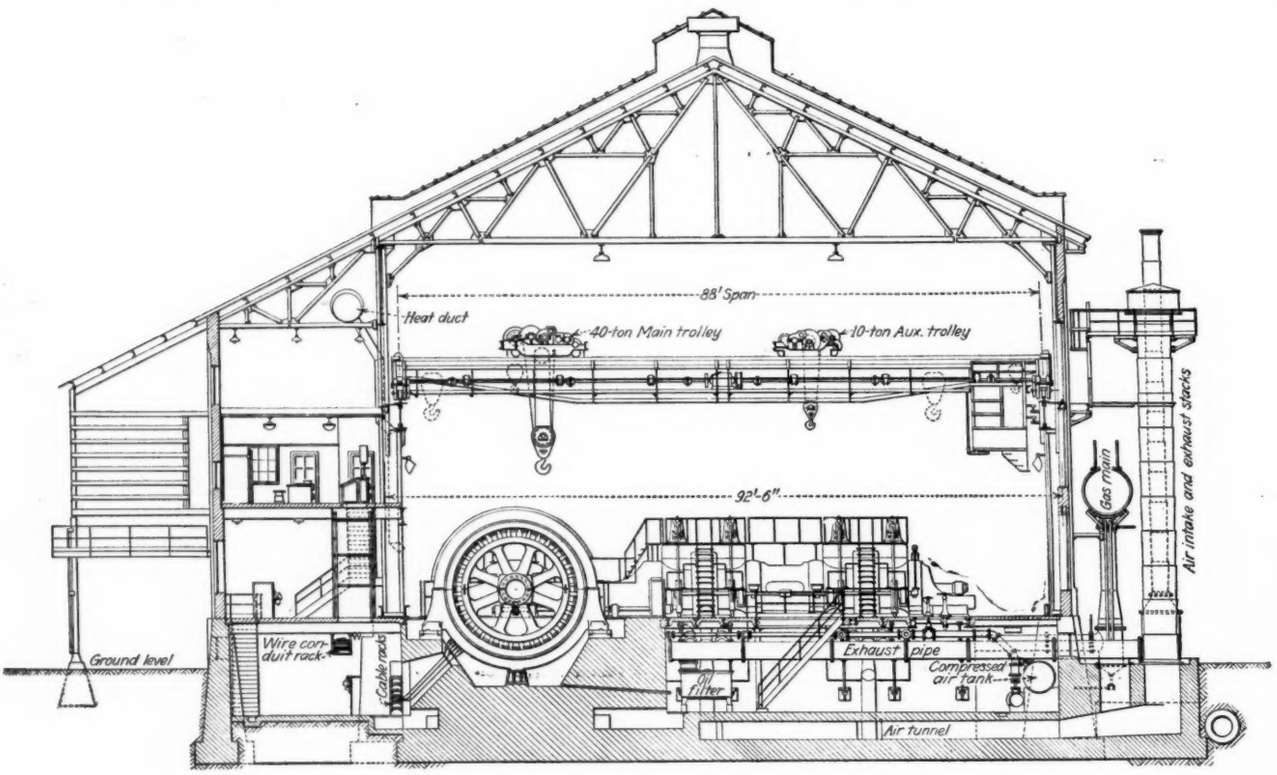


Fig. 7—Sectional elevation through station

Sanitary equipment, such as showers, toilet facilities, etc., are provided for the employees and a provision made by the safety department of the works is a case containing gas helmets and pulmotors to be used in emergencies such as may arise during an accident, while changing valves, etc. The plant also contains a machine shop for minor repairs.

Unusual precautions have been taken to insure clean air for the electrical machinery and pure air for the operating force. The smoke- and gas-laden air common to a steel mill is heated and washed before introduction into the building and the water seals at the inlet valves of the engines prevent gas leaking out into the building. The heating and ventilating unit has a capacity to supply 75,000 cu.ft. of air per minute. It consists of primary heating coils, a water spray, tempering coils and the fan driven by a 75-hp. induction motor. Distribution of the air is effected through ducts in the basement with outlets at the engine-room floor and up in the electrical gallery.

Unfortunately, on account of load demands, no accurately conducted tests have been made on this plant

and no operating data other than those given in the introductory paragraphs are available. Briefly, it may be said that economies averaging 24 per cent over the period of a month are being maintained and that the engines will carry overloads exceeding 25 per cent above rating. For machines of their size and weight the engines operate quietly with little vibration when the enormous reciprocating forces are considered. Up to the present writing no difficulty has been experienced in their operation.

The plant is operated on three shifts and seven men per shift are employed. They consist of four oilers, one for each engine, one chief engineer in charge, and two switchboard operators. This, of course, does not include the two men per shift employed in the Theisen washer building and the repair crew maintained in common for the various power plants serving the works.

For the design of the plant credit is due L. Holmboe, chief engineer for the company; G. R. McDermott, assistant chief engineer; and W. S. Hall, electrical engineer.

PRINCIPAL EQUIPMENT IN ILLINOIS STEEL GAS ENGINE PLANT

Generating units, four, 3,660 kva	Allis-Chalmers Mfg. Co.
Engines—Four cylinder, twin tandem	48x60 in.
Generators—3,660 kva. 25-cycle, 3-phase	2,300 volts
Speed—r.p.m.	83⅓
Gas, blast furnace, B.t.u. per cu.ft.	92-95
Thermal efficiency, average in service, per cent	24
Ignition sets, two, 10 kw	Allis-Chalmers Mfg. Co.
Motor	Direct current, 250 v.
Generator	Direct current, 110 v.
Exciters, two, 350 kw	General Electric Co.
Motor	Three-phase, induction, 2,200v.
Generator	Direct current, 250 v., 500 r.p.m.
Switchboard and electrical equipment	General Electric Co.
Disconnecting switches	Elec. Eng. Equip. Co.
Crane, traveling, serve engine room	Illinois Steel Co.
Main trolley	40 ton
Auxiliary hoist	10 ton
Span, ft.	88
Oil filters, four	Richardson-Phenix, S. F. Bowser & Co., Inc.
Capacity, gal. per hour	500-1,000
Lubricators, cylinder, force feed	Richardson-Phenix, S. F. Bowser & Co., Inc.
Oil coolers, four "Multiwhirl"	Griscom-Russell Co.
Oil pumps, eight, dimensions	3x2x3 in.
Oil separators, centrifugal, one	DeLaval Separator Co.
Strainers, cooling water, four, twin 10 in.	Elliott Co.
Air compressors, two, Laidlaw feather valve Cross-compound, 12x6x12 in., two-hundred lb. air	Worthington Pump & Mach. Corp.
Capacity, cu.ft. of free air per min.	300
Drive, 100 hp.ind.motor,440 v.,480 r.p.m.	
Washers, four, Theisen	John Mohr & Sons
Capacity of each, cu.ft. per min.	15,000
Drive, three 200 hp. induction motors, 2,200 v., 355 r.p.m. and one 150-hp., 250 v., d.c. motor	General Electric Co.
Heating and ventilating unit, "Chinook"	Bayley Mfg. Co.
Fan, "P.exiform," No. 13, type I, 75,000 cu.ft. air per min.	
Motor,75-hp.induction,440 v.,480 r.p.m.	
Flow meters, total gas and cooling water	Republic Flow Meters Co.

Keeping Generators in Service During System Trouble

BY C. M. KING

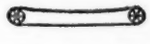
It has been found that faults of a temporary nature, such as flashovers between line conductors or to earth, can generally be cleared by momentarily reducing the line voltage to a low value, restoring it to normal after the arc is extinguished. Even if a number of units comprising an insulator are badly damaged, the undamaged disks will generally afford sufficient insulation to permit of operation at normal voltage, at least until repairs can be made, and this scheme of momentarily lowering the voltage is largely used on systems where relays are not employed to switch out faulty lines.

On some systems a device known as a field relay has been employed to reduce automatically the generator voltage to nearly zero, by simultaneously opening all the field breakers, then closing them after an interval of one or two seconds. The field relay functions when the current flowing to earth or through the line conductors reaches a definite value, and in many cases has cleared trouble, such as flashovers, with hardly any loss of load.

In some other cases a total loss of load has resulted, due to the failure of the generators or the synchronous load and the generators to return quickly to synchronism, and where rotary converters have formed part of the load, trouble has been experienced due to the polarities of these machines reversing. While the use of the field relay has been abandoned on at least one system, there are some systems, such as those on which only a small portion of the load consists of synchronous apparatus, where a field relay might prove highly desirable. On some systems where it has been found that a grounded line may be kept in service a short time without harmful effects, the best results might be obtained from a field relay if it were arranged to function only on the simultaneous occurrence of excessive ground or line current and low bus voltage. In most cases a field relay can reduce and restore the voltage much more quickly than is possible by the manual operation of a master field switch, and the success of the field relay as a protective device depends largely on the nature of the trouble, the ability of the generators to pull into synchronism, maintenance of the governor pressure for the period that the bus voltage is below normal, and the ability of the generators to withstand without damage the shocks to which they are likely to be subjected while pulling into synchronism.

Another method of automatically reducing and restoring the line voltage is to add a coil to the generator voltage regulator which, when energized with direct current by excess current or voltage relays, will hold the lower main contact lever against a stop in such a position that the generator voltage will be reduced to a low value. The regulator maintains a constant exciter voltage while the auxiliary coil is energized, but functions as an alternating-current regulator while the auxiliary coil is not energized.

Attempts have been made to protect generators and step-up transformers by excess-current relays, but unless the settings are abnormally high results will not be satisfactory, because the oil switches are likely to open by relay action at the very time when it is highly desirable that the transformers and generators be kept connected to the system. In one station, where the transformer relays had the unusually high setting of 7 sec., definite time, several total interruptions resulted because of transformer overloads which would not have been at all harmful. Such important classes of equipment as generators and transformers should be protected only by relays that will positively function when an abnormal increase in temperature occurs or when actual failure occurs.



R. L. Hemingway, in the *California Safety News*, relates a serious accident resulting from the use of a high-pressure oxygen cylinder for testing the air and gas lines in a new building. Although the oxygen pressure was 1,800 lb., a common 125-lb. globe valve was used in connecting the tank to the system and by opening the needle valve first the high pressure was put on the globe valve, causing it to burst and sever the workman's thumb.

Efficiency Tests of Raanassfoss Turbines*

Methods of Making Efficiency Tests on Two 12,000-hp. Double-Runner Horizontal-Shaft Hydraulic Turbines Operating Under a 40-ft. Head—Results of These Tests

By HALLGRIM THORESEN
Consulting Engineer, Christiania, Norway

PROVISIONS were made in the contract with both firms supplying the Raanassfoss turbines, described in the Feb. 19 issue, as to how the tests should be carried out. The measurement of the volume of water was to be made by means of current meters at the intake gates where wooden mouthpieces were to be built in. The upper water level was to be read off at four points in the flume above the turbines and the lower water level at four points at the outlet of the draft tube. The net head was to be the difference between the upper and the lower levels thus obtained. The power was to be determined by measuring the electric energy developed and applying the measured efficiency of the generator.

Measuring such large volumes of water 3,000 sec.-ft., occasions many difficulties, especially when this is to

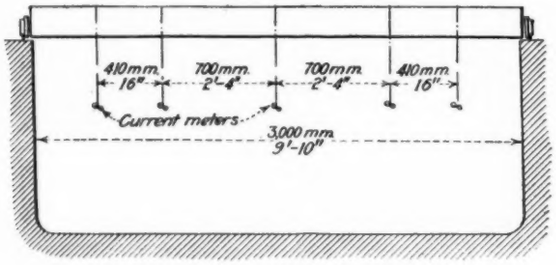


Fig. 1—Method of checking current meters

be done in a comparatively short time. The area of the gate opening in front of each turbine in this case is about 540 sq.ft. Even if a reduction in this area be made by building wooden mouthpieces for the purpose of measurement, an area of about 430 sq.ft. still remains in each of two openings to one turbine. As measurements were to be taken with current meters at 60 to 70 points, at least, in each opening and the observation at each separate point may take five minutes, at least 5 hours would be required for the readings if only one current meter were used in each opening. It was therefore important that a method should be found whereby observations could be made in less time. As the cross-section, through which the velocity of the water is to be determined, was rectangular, the measurement points were arranged along vertical lines, which lay symmetrically in relation to the side walls. With as many current meters as there were vertical lines formed by the measurement points, observations could be made simultaneously at those points lying in one horizontal. The current meter could be mounted on a frame that could be raised or lowered. Such an arrangement in this case would require fourteen current meters, and it was found possible to obtain that number.

*Based on the official report on this installation, prepared by the Akershus Elektricitetsverk.

Objections may be raised against a simultaneous measurement with a number of current meters, that one may so influence the other that the calibration factor found on testing one meter may not be correct when several are running alongside one another. In order to test this, five current meters were mounted side by side on the same carriage placed over the 10-ft. wide testing flume in the water-power laboratory at the Technical High School, Stockholm (see Fig. 1), and the calibration factors determined. A comparison of these factors with those found when testing each current meter by itself immediately before, showed that in three of the five meters the difference was less than 0.1 per cent and in the other two the difference was 0.2 per cent. The difference therefore is not greater than could be accounted for by errors in observation. The measurement of the water was carried out in the following manner:

On a level 6 ft. 7 in. (2 meters) above the bottom of the gates a plank floor was laid, which extended to the guide channels for the stop logs in one direction and to the screens in the other (see Fig. 4). The gates were raised so that their bottom edges were exactly on a level with the concrete beam in front. Immediately behind the gates and on a level with their bottom edges a horizontal plank deck was built. This deck, together with the bottom edge of the gates and the concrete beam in front of the gates, formed the upper boundary of the measurement cross-section. The gate guide channels were filled in with wood, so that the side walls were smooth and parallel from the stop-log channels to the place of the measurement.

The current-meter measurements were made at the inner end of this run (see Fig. 4). Behind this place for measurement guides were fixed to the walls of the turbine flume in which the frame carrying the current meters could be raised or lowered. Fig. 2 shows the arrangement of the current meters on the frame and the distance between the meters. On each frame seven meters were mounted and these adjusted so that they lay in the same horizontal line. The frames could be raised and fixed at levels suitable for measurement. The height of the measurement cross-section was 29.4 ft. and measurements were taken in this at ten different levels. The lowest line was about 4 in. above the bottom and the highest about 4 in. under the top boundary. The electric contact wires from the current meters were run up along the frame to the observation places. As there were two measurement cross-sections in front of each turbine, there were in all fourteen current meters in use during each measurement. In order to avoid too many observers, each one had two current meters under observation and the wires from these were coupled so that by means of a switch those meters from which for the moment readings were not being taken could be cut out. Readings of at least 60 sec. duration were made one after the other at each point.

Immediately after the tests were made, all the current meters were sent to the Technical High School in Stockholm, where they were checked by the State Meteorological Hydrographical Institute.

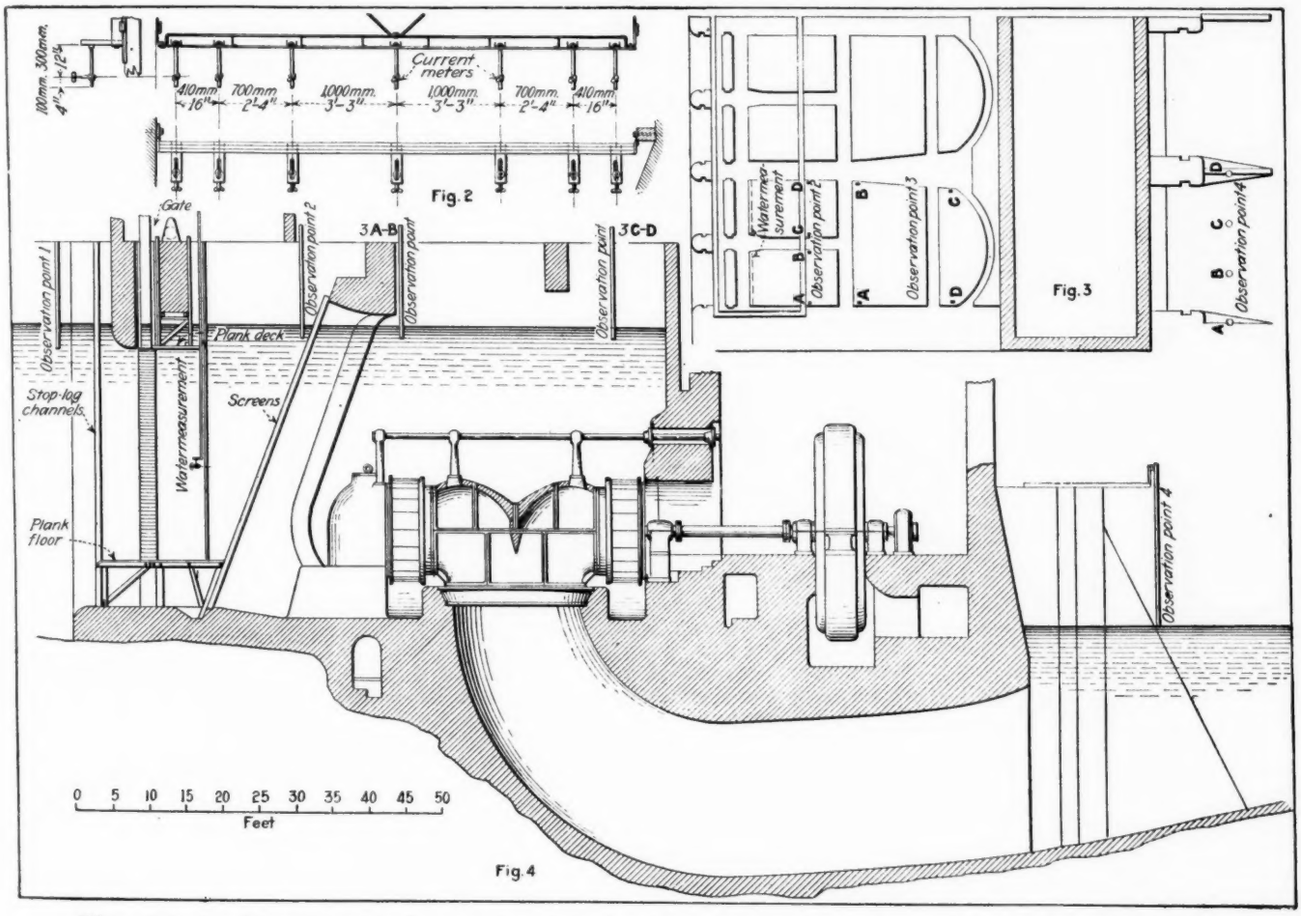
In order to determine the head, the water levels were observed at five different points (see Figs. 3 and 4).

Point 1 was on side of forebay at the power house and consisted of a fixed measuring rod. During the tests the water level was read off every five minutes.

Point 2 was in front of the screens. Four measuring rods were set up here, as indicated in Fig. 3, one on each side of the two intakes and during the tests readings were taken every four minutes. The readings

Point 5 was to one side of all discharge openings and constitutes the usual point for the measurement of the tailrace level of power stations. While the tests were carried out, there was no water discharging from draft tube No. 6, therefore the water level at point 5 must practically correspond to the proper tailrace level. The water level at point 5 was throughout the tests higher than at point 4.

A water resistance of ample dimensions was built outside the power house to absorb the energy developed during test. This was designed for the voltage of the generator 7,500 volts, and was connected by cables with one set of generator busbars. During the



Figs. 2 to 4—Arrangement of current meters, location of water-level observation points and elevation through flume and power house

at point 1 as well as at point 2 are without bearing on the efficiency, but were taken in order to get a view of the head losses of the plant.

Point 3 consisted of a measuring rod set up in each corner of the turbine flume. On these the level was read off every four minutes during the tests. These readings were taken as the headrace level for calculation of the efficiency.

Point 4 was at the discharge opening of the draft tube, and the lower water level was measured at four points by means of a movable measuring rod. In addition, readings were taken at four points just outside the adjacent draft tubes, from which, at the time, no water was discharged. The readings at these latter four points served as a check on the readings at the first. In this case readings were taken every eight minutes.

efficiency test the energy developed was measured by means of precision instruments, readings being taken every 5 min. The output was constant, as the guide-vane opening of the turbine could be kept constant by means of the load-limiting device on the governor. The time required for the tests depended upon the water measurements, and it was found possible to carry out these in about an hour and a quarter.

The calculation of the power developed by the turbine was based on the generator efficiency found by actual test. The efficiency of the generator was found to be about 1 per cent above that guaranteed.

The speed of the turbine was read off on the tachometer in the generator room. This was checked both before and after the tests. The guide-vane opening and the vacuum gage readings were also noted in the generator room.

The tests made on No. 1 turbine were conducted by a commission consisting of Elov Englesson, chief designer of Verkstaden, Kristinehamn, and H. Thoresen, hydraulic engineer, Kristiania, with Prof. G. Sundby, from Trondhjem, as refree. Water-level observations, measurement of water and power were accurately carried out in accordance with the foregoing description. During the period of testing the head was about 39.5 ft.

For measuring the vane opening for test purpose, the relation between the gate indicator readings and the actual opening of the guide vanes was determined

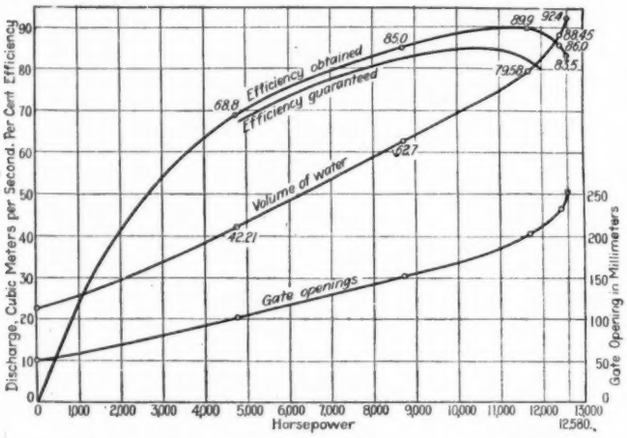


Fig. 5—Test curves for Nos. 1 to 3 turbines

beforehand. Besides the efficiency tests, tests were also made of the output at varying speeds.

The results calculated to a net head of 40 ft. are shown in Fig. 5, and the relation between the guaranteed efficiency and that obtained with a 40-ft. net head and 107 r.p.m. was as follows:

Output in horsepower	4,800	7,200	9,600	10,440	12,000
Guaranteed efficiency, per cent	67.0	78.0	84.0	85.0	80.0
Measured efficiency, per cent	69.1	80.1	87.4	89.1	89.1

The maximum efficiency measured was 89.9 per cent at 11,650 hp. According to the curve the best efficiency is at 11,360 hp. and amounts to 90.1 per cent.

The efficiency was thus considerably better than that guaranteed, and the manufacturer obtained the premium stipulated in the contract for excess efficiency. The efficiency obtained is high, especially for this type of turbine for which the discharge conditions are less favorable than with a vertical type. The results are of great interest. They corroborate the excellent results that were obtained at the Untra power station, given by Prof. Hjalmar O. Dahl in *Tekn. Tidskrift*, mechanical section 1919, No. 12. These showed that with double horizontal turbines, efficiency curves may be obtained which are equal to those of vertical turbines.

The actual turbine gave a considerably better efficiency than the test model, which is what might be expected on account of the difference in size. However, the experimental curves obtained from the models and the actual turbine are similar in shape. The simple shape of the runner buckets is doubtless one reason why the performance of the model was identical with that of the large turbines.

The tests on turbine No. 5 were conducted under the direction of a commission consisting of Mr. Schmitthenner, Dr. Ing., Heidenheim; H. Thoresen, hydraulic engineer, Kristiania, with Prof. G. Sundby, Trondhjem, as referee.

Water-level observations, measurements of water consumption and output were carried out in accordance with the previously described rules. The head was about 42.6 ft. Besides efficiency tests output trials at varying speeds were carried out.

The test results calculated to a net head of 40 ft. are given in Fig. 6, and the relation between guaranteed and obtained efficiencies at 40 ft. net head and 107 r.p.m. are as follows:

Output in horsepower	4,800	7,200	9,600	10,800	12,000
Guaranteed efficiency, per cent	65.0	76.5	83.5	85.0	79.0
Efficiency obtained	72.3	78.9	84.2	84.3	81.3

According to the curve the best efficiency is at 10,400 and amounts to 85 per cent. The efficiencies obtained at part loads were better than guaranteed, even if such high values were not recorded for the large outputs as obtained with turbines Nos. 1 to 3. On the other hand, for outputs below 6,000 hp. the efficiencies are higher than for turbines 1 to 3.

Compared with the results obtained with the model turbine, higher efficiencies could reasonably have been expected. However, the buckets have been slightly misplaced in the mold at the steel foundry, causing the discrepancy in water consumption and efficiency varying from those of the model runner. The efficiency curves for both model turbines were nearly alike. The highest point on the curve for the model Nos. 1 to 3 was about $\frac{1}{2}$ per cent above the corresponding point on the curve for the model of Nos. 5 to 6, while the latter curve was flatter than the former.

The runners of the two turbine manufacturers, which were constructed on the basis of each individual firm's

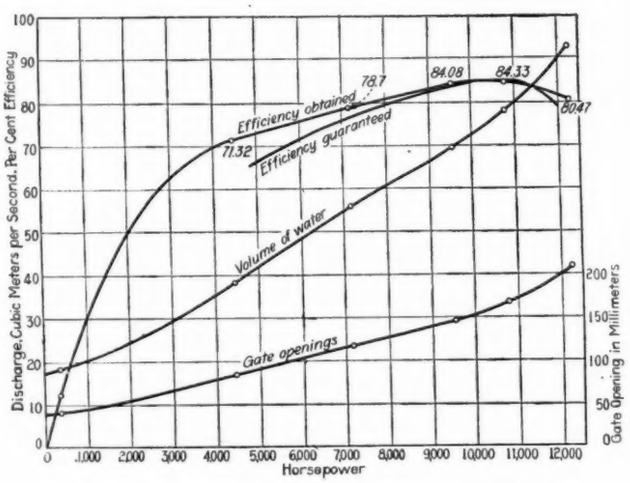


Fig. 6—Test curves for Nos. 4 to 6 turbines

experience and model tests, are essentially different in appearance and form. Verkstadens runner has few and short buckets of a remarkably plain form. The Voith runner has a larger number of buckets with larger prolonged surfaces. In the latter greater stress has been laid upon rigidity and hence the large number of buckets. A small dislocation of the buckets in the mold where a large number of buckets and long water passages are used will produce a greater influence on the turbines' behavior than when a smaller number of shorter buckets are used. It is natural to seek the reason for the discrepancy between the efficiency curves for the model of No. 4 turbine and the actual turbine in this fact.

Sulphur as an Index to Ash Fusibility

By J. A. Murray*

Since the investigations of Prost in 1895 many attempts have been made to reduce to a mathematical equation the fusibility of coal ash, but these methods are of no commercial importance because it is more difficult to determine the facts governing the fusion point than to determine the fusion point itself directly by experiment.

While not reducing the fusion point to a mathematically exact law, a study of the 1,163 determinations made in the laboratory of the Detroit Edison Co. during the last five years shows a marked relation between the sulphur content of the coal and the softening temperature of its ash.

Although these samples show a relation between the sulphur content of the coal and the fusion point of the ash, it should be remembered that sulphur, in itself, is not a cause of low fusibility and therefore a certain percentage of sulphur cannot be definitely related to a certain fusing temperature.

However, most authorities agree that the principal cause of low fusion is iron, and it is interesting to know that the results of 76 determinations made by Fieldner, Hall and Field[1], show that the percentage of iron, as Fe_2O_3, in coal usually increases or decreases with the percentage of sulphur.

In the table are given the results obtained on the

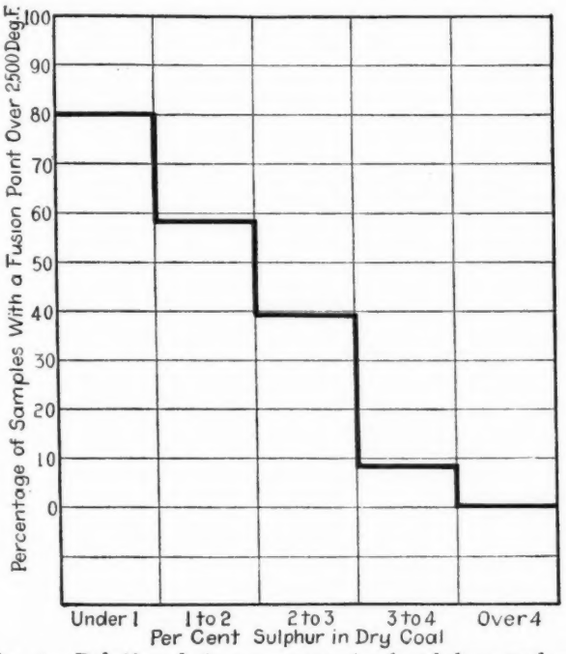


Fig. 1—Relation between amount of sulphur and percentage of samples fusing above 2,500 degrees

1,163 samples. These are weekly plant samples, taken at the stoker hoppers, and weekly average samples of cars from different mines, sampled from the conveying system after the coal had been crushed. They are from five districts in three states, all in the Appalachian Region, namely: The Cambridge district in Ohio, the Kanawha, Logan and Thacker districts in West Virginia, and the Eastern Kentucky district.

RELATION OF SULPHUR TO FUSION POINT

	Per Cent Sulphur in Dry Coal				
	Under 1	1 to 2	2 to 3	3 to 4	Over 4
Number of samples with a fusion point above 2,500 deg.	210	373	57	5	0
Number of samples with a fusion point below 2,500 deg.	51	268	86	56	57

From a study of the table it is evident that the chance of getting a coal with a fusion point over 2,500 deg.

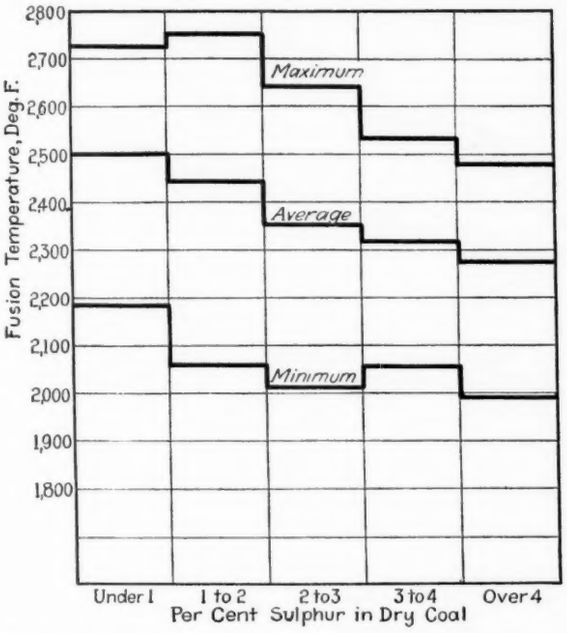


Fig. 2—Maximum, minimum and average fusion temperatures for various percentages of sulphur

(the usual standard in power-plant operation) decreases as the percentage of sulphur in the coal increases. Fig. 1 shows this in graphic form.

It is of interest to note that 16 samples, containing less than ½ per cent of sulphur, all fused above 2,500 deg.

Fig. 2 is a graph showing the maximum, minimum and average fusion temperatures of these samples plotted against the percentage of sulphur in the coal. This also shows a reduction of the average fusion temperature as the percentage of sulphur increases.

The results of a study of the low-temperature carbonization of the Pittsburgh and Upper Kittanning coals, made by the Department of the Interior in co-operation with the Carnegie Institute of Technology at the Pittsburgh Experiment Station of the Bureau of Mines, indicate that the regular Pittsburgh coal bed is a good low-temperature coking coal. When carbonized at 550 deg. C. in a stationary vertical retort, it will yield 33 to 35 gal. of tar, 3,500 cu.ft. of 600 B.t.u. gas, 1,400 lb. of 10 per cent volatile coke, and 6 to 8 lb. of ammonium sulphate per ton. The total amount of crude light oil suitable for motor fuel that was obtained directly from Pittsburgh or Freeport coal by distillation at 550 deg. C. and by cracking, is approximately 7.1 gal. per ton, or 2.6 per cent by weight of the coal. The net refined motor fuel from the process is 4.6 gal. per ton, or 1.7 per cent by weight of the coal.

*Chemist, The Detroit Edison Co.

[1]Bureau of Mines Bulletin 129, Table II, pages 27 and 28.

Periodic Examinations of Steam Turbines

Operating, reliability and economy practically sum up the value of the steam turbine. These two factors can be maintained only by proper inspections. This article contains instructions of the Westinghouse Electric & Manufacturing Co. on these points. Much of the information is applicable in a general way to other types of turbines. It is not intended to supersede any other instructions. The manufacturer should be consulted in regard to detailed advice for any particular machine in service, as this article is general in character.

IT IS good practice to subject large steam turbines to periodic examinations at intervals of one year or intervals not to exceed two years, at which time the following details should not escape critical observation:

1. *Blading*—See that no defects have developed. Look for loose lashing wires and sealing strips, eroded blades, partly developed cracks or flaws.

2. *Nozzles*—Ascertain whether there has been an injury or erosion.

3. *Blade and Dummy Rings*—See that the monel-metal seal packings at the ring fits in the cylinder are in good condition and that the rings have not gone out of round as the result of some rubbing or local heating.

4. *Valve Gear*—Determine that the valves are tight and that linkages and mechanisms have not become worn, and that the adjustments are as specified in special instructions.

5. *Throttle-Valve Mechanism* — The throttle-valve mechanism should be dismantled and examined and the main valve and pilot valve made steam-tight on their seats.

6. *Governor*—The governor should be examined and it should be ascertained that all fits and knife-edges are in good condition. Examine worm-gear drive.

7. *Main and Auxiliary Oil Pumps*—Main and auxiliary oil pumps should be examined, together with their worm-gear drives.

8. *Bearings and Thrust Bearing Shoes* — Examine bearings and thrust bearing shoes and remove any abrasions. All oil ducts and grooves should be explored and cleaned.

9. *Coupling Surfaces*—Coupling surfaces should be gone over, and all interior oil cavities and oil holes cleaned out.

10. *Oiling System*—The oiling system should be thoroughly cleaned and all sludge removed.

11. *Cylinder and Heaters*—See that all drain openings are clear and free from débris, and in particular, the monel-metal orifices in the turbine drain lines.

Check all clearances.

Test the oil cooler to see that it is tight.

Test the feed heaters to see that they are tight.

12. *Dismantling*—To dismantle the machine for examination, the throttle valve with its first length of piping should first be removed. This is readily accessible as before described. Doing this precludes any steam from locally heating the turbine from leaking valves, which would interfere with observations of alignment.

Certain lagging sheets only need be removed, giving access to all bolting. The connecting piping between the steam chest and the secondary and tertiary nozzles must be in part removed.

If the crane has sufficient headroom and capacity, it is easier to remove the turbine cover without dismantling the steam chest. To apply the lifting gear, however, it will be necessary to remove the oil relay and operating cylinder and their connecting linkage. Make the separation at the rectangular flange where the operating cylinder bolts onto the valve bonnet.

If the crane does not have sufficient headroom and the steam chest must be first removed, a special lifting gear should be provided. In breaking the joint where the steam chest connects with the primary nozzle chamber, be careful to avoid buckling of the joint seal plate.

13. *Checking Levels When in Operation*—Any time after the turbine is erected and in service, determinations may be quickly made as to whether the levels that obtained when first erected have remained constant. This may be carried out either with the turbine in operation or shut down. This is invaluable if there is suspicion that some portion of the foundation may have settled.

To make these determinations, check the planes of elevations of measuring stations in the manner described and illustrated in standard instructions. The general plan is indicated in the May 15, 1923, issue of *Power*, describing a large turbine.

If any readjusting is done, first make a complete survey to determine the highest point, and afterward bring the low points up to this plane.

Remember that if the turbine is at operating temperature, certain measuring stations should be in the same plane. If the turbine is cold, some of them will be a definite amount lower. It is thus possible to check leveling and determine if foundation settling has taken place.

It is emphasized that the first leveling and aligning be thoroughly carried out and observations clearly recorded in the logbook, so that any subsequent leveling may be checked.

These measuring stations should always have protecting plugs in them to preserve their faces from injury, a set of these plugs being furnished with each unit.

In any subsequent checking the levels between No. 2 and No. 3 bearings, counted from the governor end, should also be examined, as there may be some deformation by ageing of the large low-pressure exhaust chamber structure that may affect the alignment of the field. The leveling plan as a whole affords a closer check on alignment than that in which the bedplate only is checked.

14. *Vibration*—Balancing machines of a high degree of sensitiveness have been developed, which are used in the manufacturer's erecting shop in order to obtain precise balance at slow speed of all the rotors before shipment.

This precise balancing will not necessarily insure smoothness of operation unless many other details have received proper attention, some affecting the balance itself.

Vibration of any kind frequently presents a complex problem and is doubtless the most difficult one that confronts the service engineer. Any vibration should be regarded seriously, for the life of a turbine and generator is to a great extent dependent upon freedom from vibration.

Among many of the causes of vibration of a machine whose rotor has been accurately balanced dynamically at slow speed may be cited the following:

1. A static unbalance, say near the middle of a rotor, which has been corrected by balancing at slow speed by adding weights at the ends of the rotor. When operated at speed, there will be a centrifugal couple, which, if of sufficient magnitude, will cause a bending of the rotor and consequent unbalance.

For this reason the elements of rotors where practicable are separately given a static balance before they are assembled and dynamically balanced at slow speed.

2. Journals out of round; thrust disk not running true.
3. Loose objects in rotor.
4. Movement of blades or field coils in their holding slots, due to centrifugal force or temperature effects.
5. Seasoning or ageing of the spindle parts resulting in a slight change of shape.

It is usually found necessary to rebalance spindles after they have been once operated by steam at overspeed.

6. Loosening of press fits either because of their having been primarily inadequate or as a result of a temperature difference between respective elements.
7. Misalignment of generator and turbine rotors due to sinking of foundations, or to temperature or vacuum effects on the exhaust chamber, or caused by the twisting moments on the turbine foundation or cylinder structures because of the power transmitted.
8. Coupling driving faces not bearing equally against the coupling parts when central, thus producing a couple that will cause the connecting parts to run eccentric.
9. A machine having been put in operation with the spindle not evenly heated. It has been generally found that the spindle will not straighten itself unless the speed is brought down and the spindle evenly heated at slow speed.
10. Synchronism or near-synchronism between the r.p.m. and the natural frequency of one or other of the parts of the unit or its foundation either in vertical or horizontal planes.

Heat Transfer in Brine Hold-Over Tanks

By CHARLES H. HERTER

INTERMITTENT refrigeration is resorted to in situations where it is inconvenient to operate the refrigerating machine more than 10 to 15 hours per day. Since the room temperature tends to rise during shut down, plants of 15 tons capacity and smaller are provided with "hold-over tanks" containing brine, which is cooled down and partly frozen during the operating time of the machine, to act as a reservoir of cold, thereby minimizing temperature fluctuations.

There are three types of hold-over tanks. The first and original brine-storage tank system is one in which the brine is cooled either by direct expansion coils submerged in the tank or by some cooler outside of the tank, the brine being pumped through pipe coils supported from the ceiling or walls of the refrigerated room. In this case either salt or calcium chloride brine is used of such strength that no freezing occurs on the brine cooling surfaces. According to Siebel the net volume of brine in the tank should be about 60 cu.ft. per ton of refrigeration, but some optimistic salesmen consider half that amount as ample. If we assume that the night load is one-third of 288,000 B.t.u. per ton capacity, then 60 cu.ft. of salt brine will have its temperature increased by $\frac{288{,}000 \times \frac{1}{3}}{60 \times 58} = 27.5$ deg. F., as from 0 to 27.5 deg. In this formula 58 is the heat content of one cubic foot of salt brine per degree F. For calcium brine it is only 52, necessitating a temperature rise of 30.75 deg. Clearly, 30 cu.ft. of brine can do but one-sixth of the day's work.

Many manufacturers are able to obtain a heat coefficient K from ammonia to the slowly moving brine of not over 7 to 9 B.t.u. per sq.ft. per hour per degree of temperature difference in these brine cooling tanks. The heat transfer can be improved by the use of narrow tanks, partitions, short flooded coils with liquid separator, and ample brine circulation as required by six or less degrees brine range, and with first class design K may be increased to 30 and 35 B.t.u. (see article "Testing Ammonia Refrigerating Plant," *Power*, Nov. 27, 1923). Siebel further indicates that brine tanks may contain 163 to 200 ft. of 1-in. expansion pipe per ton of refrigeration. If 200 ft. 1-in. pipe are active the full 24 hours with 20 deg. difference, K must be

$$\frac{288{,}000}{200 \times 0.3443 \times 24 \times 20 \text{ deg.}} = 8.71 \text{ B.t.u.,}$$

0.3443 being the surface area in square feet of one linear foot of 1-in. pipe.

Should, however, the expansion pipe in the tank be in use 12 hours only per day, K would necessarily have to be 17.42 B.t.u. or else the temperature difference must be doubled. Hence, instead of blindly accepting any arbitrary allowance of feet of pipe per ton, one should be governed by the various factors involved.

The second type of hold-over tank is invariably placed directly into the room being refrigerated, preferably overhead in a bunker, to secure as much height as possible for the ascending column of air and with it good circulation and better cooling capacity of surfaces. Frequently, more than one tank is necessary not only to contain a sufficient volume of non-freezing brine, but to gain sufficient air-swept tank surface to absorb the required amount of heat, each exposed square foot of tank surface being able to receive but 1 to 1.5 B.t.u. per sq.ft. per hour per degree of difference in temperature between the tank surface and average air in the bunker. An amount of expansion pipe should be placed into each tank sufficient for the easy removal, during the running period of the machine, of all the heat the brine tank is absorbing in the full day of 24 hours. Any heat not removed by tank surface must be taken care of by exposed direct expansion piping.

Often the latter amounts to 40 or 50 per cent of the total pipe surface in the room. According to one rule of thumb, brine tanks should contain one cubic foot of brine for each 30 cu.ft. of space if shutdown lasts 12 hours.

Where so many variable factors enter into a problem, one must not expect to receive accurate results from the use of such rough rules of thumb. At some future date it may be possible to offer more rational formula.

So long as plain brine only is used, the heat capacity per cubic foot is only about 58 B.t.u. with salt brine, or 52 B.t.u. with calcium brine. A third type of hold-over tank has been devised possessing every advantage of the first two types and in adition being more compact. In this case the latent heat of frozen brine is utilized and but one-seventh the normal volume of tank is required. This tank was used for many years as a regular brine congealing tank, but Baars' design includes several clever modifications to make it more effective. Some manufacturers make their congealing tanks 3 or 4 ft. high, while Baars makes them 2 ft. high or less. Any low radiating surface is more effective per square foot than a high one as is well known to heating engineers. To provide against bulging due to uneven freezing, he uses corrugated sheet metal for the sides of tank, the corrugations running vertically, which, incidentally, increases the surface in contact with air. The width of tank over the corrugations is only 4 in. For a room 10 ft. long he uses one tank 9 ft. long, 2 ft. high, containing one expansion coil including seven 1¼-in. pipes 8 ft. 6 in. long, 3 in. pitch.

How to Calculate Size of Congealing Tank

To show how the size of brine congealing tank may be arrived at, we will recalculate an example given by Mr. Baars with some unimportant modifications in results. Problem: Cool to 35 deg. F. a meat storage room 16x8x7 ft. high. Insulation, 4 in. corkboard. Machine to operate 19 hours per day. Maximum air temperature in basement where room is located, 75 deg.; on first floor, 85 deg.; ground temperature, 65 deg. Fresh meat to be cooled daily, 1,000 lb. at 50 deg.

Heat flow through insulation, figuring conservatively, $= 10 \div 4 = 2.5$ B.t.u., sq.ft. 24 hr., per deg. difference.

Heat to be removed per 24 hours

Floor, $16 \times 8 \times 2.5 \times (54 - 35$ deg.)	=	9,600 B.t.u.
Ceiling, $16 \times 8 \times 2.5 \times (85 - 35$ deg.)	=	16,000 "
Walls, $48 \times 7 \times 2.5 \times (75 - 35$ deg.)	=	33,600 "
Cooling meat, 1,000 lb. $\times$ 0.7 $\times$ (50 — 35 deg.)	=	10,500 "
Volume of room, 896 cu.ft. say 4 air changes per 24 hours (including the removal of the latent heat of the moisture content)	=	6,300 "
Total work for 24 hours		76,000 B.t.u.

(Mr. Baars estimated on total 59,444 B.t.u.)

Machine capacity required for 10 hours with 0 deg. F. evaporator temperature

$$\frac{76{,}000}{10 \times 12{,}000} = 0.633 \text{ ton refrigerating capacity.}$$

The heat influx during 14 hours' shutdown may be estimated to be equal per hour to that in the daytime; namely, $59{,}200 \times \frac{14}{24} = 34{,}500$ B.t.u., or nearly one-half the total work. The latent heat of a cubic foot of frozen calcium brine being 8,400 B.t.u., 4.1 cu.ft., or 233 lb. ice, are to be melted during shutdown. Allowing 2 lb. ice to form per lineal foot of 1¼-in. pipe (ice coat less than one-inch thick), $233 \div 2 = 116.5$ lin. ft. of pipe are required. At 3.5 lin. ft. of pipe per 19 ft. wetted tank front 33 sq.ft. are required. If brine stands 1½ ft. deep, the total tank length must be 22 ft., say two tanks each 11 ft. long made 2 ft. high and 4 in. wide. To save space and money it may be necessary to use but one tank 11 ft. long and 40 in. high. Exposed effective (projected) tank surface then becomes 66 sq.ft. Figuring in this case with $K = 2$ B.t.u. the tank surface can do $66 \times 2 \times 14$ hr. = 1,848 B.t.u. per deg. temperature difference, hence the difference must be $34{,}500 \div 1{,}848$, or 18.7 deg., and the freezing point of the brine must be 35 — 18.7, or about 16 deg. F. During 10 hours' run in the day time the tanks do at least $34{,}500 \times \frac{10}{24}$, or 24,680 B.t.u., which, added to 34,500 B.t.u. night work, equals 59,180 B.t.u., thus leaving but 16,820 B.t.u. to be done by exposed expansion piping.

To check whether the 116.5 ft. 1¼-in. pipe in tanks can remove 59,180 B.t.u., we note that

$$\frac{59{,}180 \text{ B.t.u.}}{116.5 \text{ ft.} \times 0.4346 \times 8 \text{ B.t.u.} \times 10 \text{ hr.}} = 14.6 \text{ deg. dif.}$$

are required, which necessitates a vapor temperature of 16 — 14.6, or + 1.4 deg. F., or 17 lb. ammonia evaporator gage pressure.

With the exposed piping we therefore have fully 30 deg. difference, so that with $K = 2.15$ B.t.u. we need

$$\frac{16{,}820 \text{ B.t.u.}}{0.4346 \text{ sq.ft.} \times 30 \text{ deg.} \times 2.15 \times 10 \text{ hr.}} = 60 \text{ ft. } 1\tfrac{1}{4}\text{-in. pipe}$$

or its equivalent.

This amount of exposed piping is 34 per cent of 176.5 ft., the total piping used. Of course, where five or more degrees temperature rise is permitted during shutdown or where the compressor is longer in operation, the amount of exposed pipe and tank surface will be different.

In actual commercial practice convenient approximations are used to simplify calculations, but even the foregoing analysis is not scientifically exact. For example, it is really incorrect to use a constant value for K per degree of difference for every temperature range. The heat loss from canvassed covering is shown by L. B. McMillan, in his paper on "Heat Limiting Properties of Commercial Steam Pipe Coverings," before the American Society of Refrigerating Engineers, to be about:

1.3 B.t.u. sq.ft. hour deg. at 20 deg. difference
1.33 B.t.u. sq.ft. hour deg. at 30 deg. difference
1.375 B.t.u. sq.ft. hour deg. at 40 deg. difference
1.44 B.t.u. sq.ft. hour deg. at 50 deg. difference

In other words, the smaller the temperature difference the poorer is the rate of heat transfer K per degree of difference. Confirmation of this circumstance is given also by C. Heinel, who obtained two curves for K for brine tank surface to air, a low one applying at night when the cold chamber is closed up and the air circulation is weak, and a higher one in the daytime when some air agitation is obtained from frequent opening of doors. His values are as follows:

Temperature difference, deg. F.	4	8	12	16
K, daytime	0.4	1	1.8	3
K, night	0.2	0.6	1.2	2

Another result found by Heinel is that in the daytime, where the brine temperature is gradually being

lowered, the drying effect of the cold surface upon the air is increasing steadily, while, with the machine shut down and the brine temperature in the cylinder rising, the relative humidity also increases until at no temperature difference in either case the curves arrive at 100 per cent relative humidity.

The values of the relative Humidity of Air at Given Temperature Differences were:

Humidity, per cent	90	80	70
Deg. F. difference required:			
a. with brine temp. falling	5.5	12	20
b. with brine temp. rising	8	20	

The congealing tank with brine frozen at some temperature 20 or more degrees below that of the room offers a distinct advantage over the ordinary brine hold-over tank. In fact, if calcium is used which, unlike salt, does not precipitate out, every hold-over tank should be of congealing type, its surface having a more constant low temperature.

Some manufacturers use cylindrical tanks, for example, 24 in. in diameter, containing an inner flue 15 in. in diameter, 24 in. high, with a helical expansion coil in the brine space. The helical coil is advantageous because offering much less resistance to flow than do zigzag coils, but the value of *K* for the frosted surface must be rather low, the bottom and top being only slightly effective, and in the 14-in. diameter hole the effect of radiation may be nil.

It is best to expand first in the coils immersed in tanks and then through the exposed piping, because for a distance after the expansion valve there is mostly liquid, and as the heat transfer from liquid to liquid is much better than from vapor to liquid, as is proved by the flooded system, and as the velocity of flow at the start is not great and therefore causes least resistance, it is best to flow through the exposed piping last. This also protects the compressor better against flooding by liquid. Often poor results are obtained because of the excessive length of piping connected to one feed valve, the tail end of the coil containing only superheated vapor. In an ideal layout the evaporating pipe should start with say ¾-in., gradually increase to 1-in., and finish up with about 1¼-in., to offset the constantly increasing volume and velocity of the vapor.

It is also important to avoid loops and liquid traps as much as possible because these impose unnecessary friction. It is better to feed upward in one coil and downward in the next, than to insist on constantly feeding in the same direction.

A common mistake in small plants is the use of too small a suction line to the compressor. These machines frequently operate at low evaporator pressures, resulting in large volumes of vapor and excessive velocities, so much so that liquid is pulled along. It would seem much better from the viewpoint of efficiency and safety to use an extra-large suction pipe so as to diminish the velocity and provide for a better filling of the compressor during the suction stroke, particularly so in the case of fast-running machines.

The refrigerated air should flow first over the hold-over tank and then across the exposed pipes, because these have the lowest temperature in the system. They dry the air, increase its density and thus help to keep up air movement.

Discussing future heating possibilities in the March issue of the *Heating & Ventilating Magazine*, Samuel R. Lewis predicted the more general use of the unit heater and of radiators of the automobile type.

Steam Boilers

A Catechism by Warren Hilleary Served in Small Doses and Extending Over a Number of Issues

103. What objection is there to inserting trays of unslaked lime in boilers that are laid up?

The lime attracts and absorbs moisture. The chemical reaction that takes place causes fumes to arise which are thought by some to attack the metal. Frequent changing of the lime will remove the objection.

104. A boiler suddenly develops a leak at a longitudinal seam. The leak appears to extend the length of the space occupied by about four rivets. What action would you take?

The leak may come from a crack in the inner lap of the seam between its outer surface and the inner surface of the outer lap. If the crack extends through the sheet it may be possible to detect it, but if it does not extend clear through the sheet, it cannot be observed and therefore the seam would have to be taken apart for a proper examination. Where such a leak is found, the boiler must immediately be blown down.

105. When drilling holes in a boiler sheet to accommodate rivets for pipe flanges, what precaution must be taken with respect to the location of the centers of the rivet holes; that is, what should be the relation of these centers to any particular point on the shell?

See that the fewest possible number of holes are placed in a line parallel with the axis of the shell.

106. The ends of the mud ring in a boiler butt together but are not welded. What should be done?

The mud ring should be made continuous by welding. Unless the mud ring is continuous, leakage eventually will appear in the vicinity of the butt.

107. How would one calculate the safe working pressure of a convex head in the drum of a water-tube boiler, assuming that one did not know the radius to which the head had been bumped?

To find the radius of a sphere of which a bumped head forms a part: Square half the diameter of the head. Divide the product by the height of the bump, then add the height of the bump. The result will be the diameter of the sphere. Dividing the diameter of the sphere by 2 gives the radius of the convex head. Next, subtract 0.125 from the thickness of the head and multiply by twice the tensile strength; divide the product by 5.5 times the radius. The quotient is the safe working pressure.

108. A 3½-in. tube ruptures in a water-tube boiler. No other tube is available. What repair may be made to permit continuance of operation?

If the exploded tube has one good portion sixteen inches long, or two good portions each eight inches long, cut from the old tube two nipples, each eight inches long. Weld over one end of each and expand the unwelded ends into the drums in the same manner as if a complete new tube were being inserted.

109. Certain tube ends in the mud drum of a Stirling boiler are generally beaded. If you found a Stirling boiler with no tube ends beaded in the mud drum, would you recommend beading, and if so, what tubes should be beaded?

Alternate tube entering the top center of the drum should be beaded. This permits better circulation than flaring and lessens the possible accumulation of scale in the top of the mud drum.

Assembling Generator Rotors

By Ralph Brown

To avoid the use of the costly special equipment that would have been required to press the spiders of the generator rotors on their shafts while cold at the Caribou Plant of the Great Western Power Co., they were heated by steam. Vertical assembly of the spiders was decided on to avoid the construction of special supporting cribs as well as the difficulty of drawing the spiders on the shaft while in its normal horizontal position.

The rotors of Nos. 1 and 2 generators were assembled before the basement and generator-room floors were placed, therefore ample headroom was available for lowering the shaft into the spiders. The spider was placed in a tank, covered with cold water, and its temperature increased to 92 deg. C., (198 deg. F.). The shaft, suspended vertically, was then carefully centered over the spider, being lowered into position as the hot water was quickly emptied by opening a trapdoor beneath the hub, and through which the shaft finally projected. After cooling, the shaft and attached spider was lifted from the tank, the trapdoor closed and made watertight. The second spider was then placed in the tank, covered with water and heated. When sufficiently heated, the water was again drained and the shaft lowered into the bore of the hot spider. This process was followed until the spiders were assembled, and no difficulties were experienced.

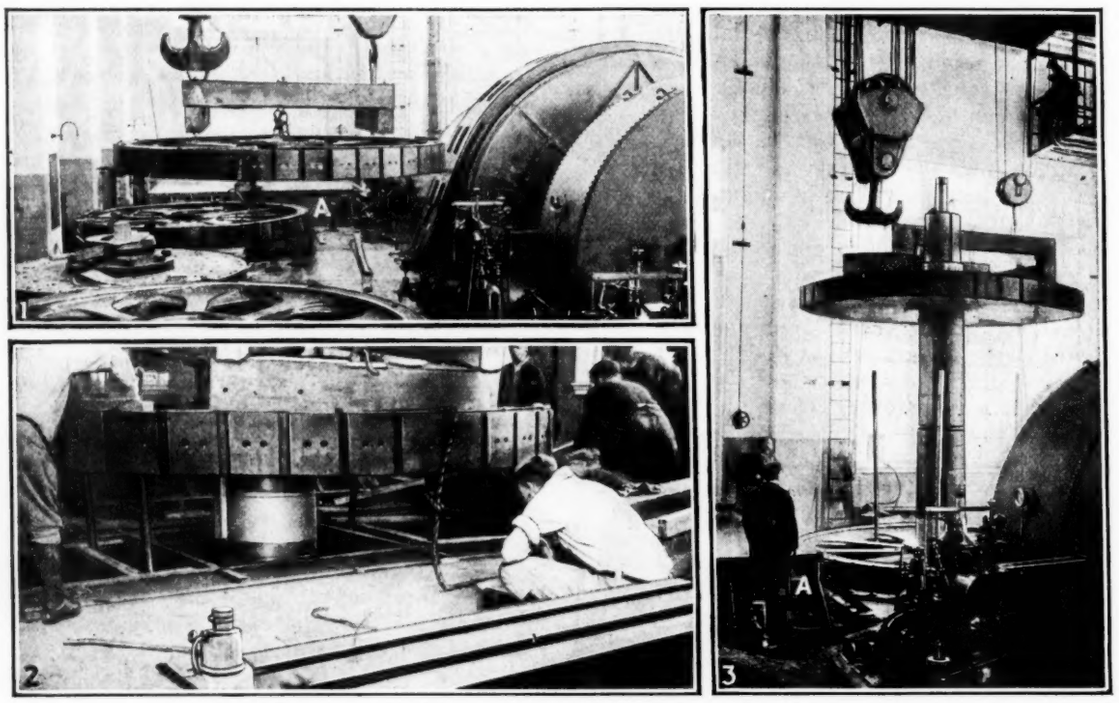
Owing to lack of headroom when No. 3 generator was erected, it was not possible to lower the shaft into a spider. The floor clearance (6 in.) was obtained only by removing the large hook from the crane and handling the shaft by means of a special stud screwed into its hollow center. Greater clearance could have been obtained by using the small hook, but it could not handle the weights involved. Sufficient headroom for handling the spiders could be had only by placing the shaft, which is 30 ft. 2 in. long and weighs 32 tons, in a vertical position in a permanent repair pit, the basement floor forming the bottom of this pit.

In assembling the four cast-steel spiders of the rotor of No. 3 generator, which has the same rating as the other two machines (22,222 kva.), use was made of the heating tank shown at *A*, Figs. 1 and 3. The sides and bottom were constructed of $\frac{3}{4}$x8-in. lumber, the framework consisting of 2x4-in. material. The inside dimensions of the tank were 16x16x2 ft., and it was lined with 0.0375-in. galvanized sheet iron, the joints being lapped and soldered.

Steam for heating the water in the tank was generated in a small vertical boiler placed outside the building. The fuel consisted of buckwheat size coal and discarded packing material, combustion being aided by compressed air. The boiler pressure was 40 lb. per sq.in. Steam was admitted through a number of $\frac{1}{8}$ in. holes drilled in two 12-ft. lengths of 1-in. pipe laid on the bottom of the tank.

After removal of the rust-preventing compound applied at the factory, the diameter of the bore and the dimensions of the spider keyway were checked against the diameter of the shaft and the width and thickness of the rotor key. The rotor key weighs 245 lb., its dimensions being 3 in.x5 in.x5.75 ft.

The spider was attached to a wooden lifting frame, Fig. 1, by means of cable slings secured to two spokes. After the spider was balanced, the cable slings were tied and wedged to prevent movement. The loops at the ends of the slings were made long enough to remain above the water level. After supporting blocks were equally spaced about its lower rim, the spider was immersed in the tank, the lifting frame then being disconnected by drawing two clevis pins, and removed.



Figs. 1 to 3—Method of handling and assembling rotors

Owing to the small boiler employed, 36 hours was required to increase the temperature of the first spider from that of the room, 68 deg. F. to 198 deg. F. The temperature of the cold water was 43 deg. F. It took eighteen hours to heat each of the three spiders that were successively immersed in the tank of hot water.

The maximum diameter of the shaft is 30 in., it being reduced 0.0625 in. for each of the three adjacent spiders. The diameter of the bore of each spider was, at 68 deg. F., 0.005 in. less than the diameter of its corresponding section of shaft. Each spider weighs 16 tons, its outside diameter is 14 ft. 1.375 in. and its width 13¼ inches.

After being maintained at 198 deg. F. for 5 hours, the spider was attached to the lifting frame and raised from the tank. The finished surfaces of the hub were then quickly cleaned and the expansion of the bore measured. The diameter of the bore of each spider at 198 deg. F., was 0.024 in. greater than at 68 deg. F. The shaft and key were painted with a mixture of white lead and engine oil before the spider was placed on the shaft. While being slowly lowered, Fig. 2, the spider was carefully guided to avoid cutting or gouging. Each spider was placed in position twenty-five minutes after its removal from the tank, two men operating the 175-ton crane. The necessarily perfect alignment of the dovetail slots for holding the 42 polepieces was obtained by driving a rectangular key between special guides inserted in two diametrically opposite slots, the guides and key extending between the spider last set, and the one being lowered into position.

Measuring the Feed Water in a Boiler Test

By J. W. Gavett, Jr.*

In making boiler tests in small or medium-sized industrial plants, one difficulty may always be expected. This is the arrangement of the apparatus for measuring feed water. It is not safe in tests, where the greatest possible accuracy is desired, to rely on meters that may be already installed. In fact, these tests should be used to check the accuracy of such meters. It is therefore, necessary to install some measuring apparatus on the low-pressure side of the feed pump, and this is where the difficulty arises. Rarely, if ever, is the feed piping so arranged that the installation is at all easy.

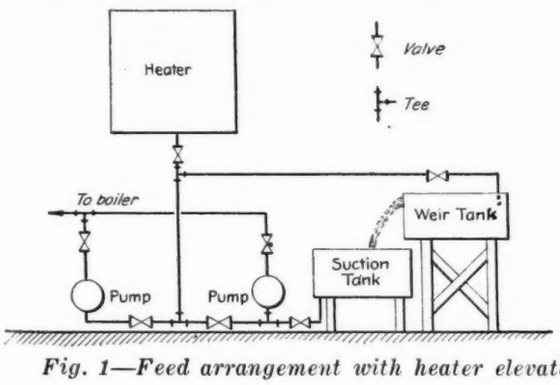


Fig. 1—Feed arrangement with heater elevated

The necessary apparatus will consist of tanks, either for weighing the water directly on scales or for volumetric measurement by means of a weir. The weighing method is, of course more accurate, but requires more room and more attention since there must be two tanks in parallel, discharging by gravity into a third tank, to which is attached the pump suction. The upper two tanks must be alternately filled, weighed and emptied. This necessitates one man to each tank and a great deal of manipulation of valves and scales. If a weir is used, only two tanks are necessary and one man can easily take all readings and handle the one necessary valve. In either case all tanks must be above the level of the pump suction.

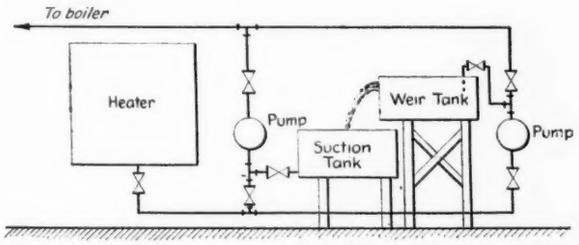


Fig. 2—Feed arrangement where water must be raised to weir tank

The next question is that of cutting into the feed line so that the water may be bypassed through the tanks. This invariably involves breaking fittings and occasionally interrupting the operation of the plant for a short time, which is, of course, frowned upon by the management and does much to bring the whole matter of testing into disfavor. It is evident that this difficulty would not arise if a few plugged tees were used in the feed piping in place of elbows, and one object of this communication is to urge designers of piping systems to bear this point in mind when making a layout. If tees are placed at the outlet of the heater or tank supplying the feed, in the suction line of each pump and in the discharge line of each pump, measuring apparatus may be installed with little trouble.

The two self-explanatory sketches, Figs. 1 and 2, will cover almost every case encountered. Fig. 1 shows the simpler case where the heater is elevated sufficiently to permit gravity flow into the upper tank. Fig. 2 illustrates the more usual type of layout in which both pumps must be used, one to lift the water into the tank and the other to feed the boilers.

The weir or "V-notch" tank offers a reliable and inexpensive method of measuring water. The tank the writer has used on a number of tests is made of wood and is about 6 x 3 x 3 ft. The weir is a 90 deg. notch cut in a brass plate and mounted at one end of the tank. The notch has a depth of about five inches, which gives it a maximum capacity of about 40,000 lb. per hour. The head is measured by a float arranged as in Fig. 3.

If the weir is well made with a clean sharp edge upstream and is set level, no great amount of care is necessary in arranging the rest of the apparatus. One precaution must be observed, however, in getting the zero float reading; that is, the reading when the water is exactly on a level with the bottom of the "V notch." This must be taken when the water is at the same temperature as will obtain during the test since the float will sink deeper in hot water than in cold, the difference being serious for changes of 50 deg. or more in the

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temperature of the water. Readings should be made at short intervals if the flow fluctuates. The writer's practice is to have readings taken every thirty seconds. This gives 1,200 readings during a ten-hour test and very close accuracy is assured.

The best method of computing the quantity of water from the readings of head is to plot a curve between

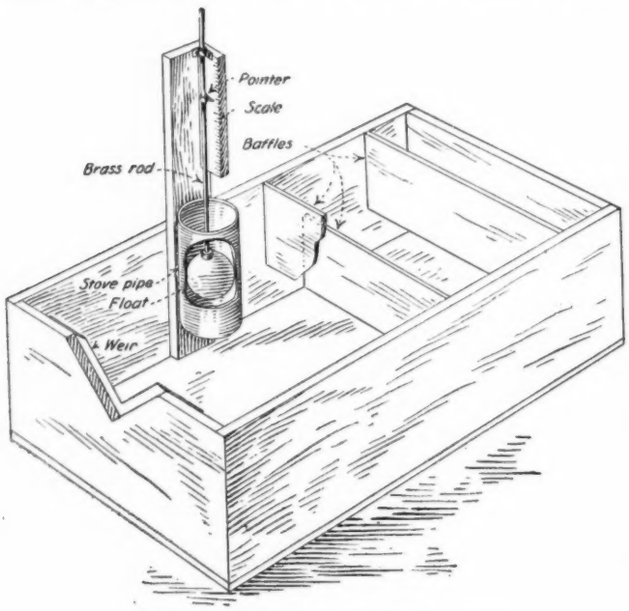


Fig. 3—Weir box with float gage

head and quantity, using one of the formulas given in various handbooks; for example, $Q = 0.305\ H^2 \times \sqrt{H}$ (Kent, page 778), where Q = cu.ft. per min. and H = height, inches, of still water behind the notch, measured above the bottom of the notch. Once made. this curve will serve as long as the weir is used. It must be noted that a value of quantity must be read from the curve for each reading of head. Averaging the heads and reading one value of quantity will give an incorrect result, since the average of the square roots of a series of numbers is not the same as the square root of the average of the numbers. Calibration of the weir against weighing tanks in the laboratory has indicated that this formula will give results accurate within one per cent. Care must be used in converting volumetric measurements to weight, to use the density of the water corresponding to the average temperature during test.

Especial care must be taken to make sure that all the water leaving the pump actually goes to the boiler. In many plants the feed line has been tapped into here and there to get hot water for various purposes. Every line loading from the feed line should either be blanked off or broken at some point beyond a valve so that leakage can be either prevented or detected and measured. The person in charge of the test should check these things for himself and take no one's word for the tightness of the valves or the destination of the pipe lines. The writer remembers only too well making this mistake and having a long test entirely spoiled by overlooking a ¾-in. line that was passing about 5,000 lb. of feed water to the sewer every hour. No one knew what the line was for nor how long it had been open. It did, however, explain the high evaporation that the monthly plant records showed—a rate somewhat in excess of that in the largest central stations—in which everyone concerned took much pride. The real rate turned out to be about 6.5 lb. per pound of coal.

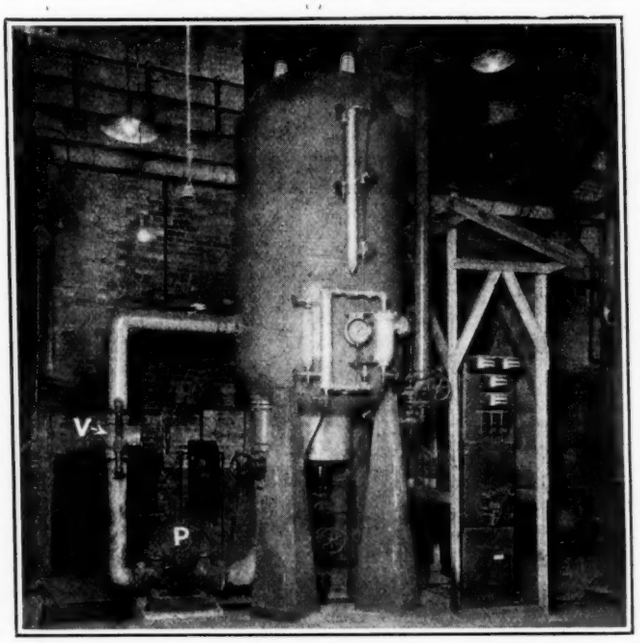
The measurement of feed water is one of the two absolutely vital factors in a boiler test, the other being the weighing of coal. Many other measurements are desirable, but the accuracy of these two must be entirely certain before anything else is considered.

Electric Steam Boiler Used To Utilize Excess Water Power

A recent application of an electric steam generator is the installation of one of these units in the Hudson Falls, N. Y., plant of the Union Bag & Paper Co. This plant is devoted to the manufacture of paper, paper bags and other paper products, and the steam generator recently installed will furnish steam for heating purposes and process work throughout the plant.

The generator, shown in the figure, was built by the General Electric Co. It is rated 5,000 kw. 6,600 volts, is designed to generate steam at 100 lb. pressure and will evaporate over 16,000 lb. of water per hour. The generator operates in parallel with fuel-fired boilers, but its operation is mostly confined to periods of high water and non-working days, when an excess of water is available for operating the power-plant generators.

In the Hudson Falls plant the operating conditions are such that the steam demand is constant and the steam generator, for this reason, is equipped only with hand control, which consists of a valve V in the discharge side of the hot-water circulating pump P. This valve is used to regulate the water level in the electrode



Installation of 5,000-kw. electric boiler

chamber of the generator to such a height as to convert into steam whatever power is available up to the capacity of the generator.

The generator is in the same room as the fuel-fired boilers and takes up a floor space of approximately six by ten feet, with a 24-ft. headroom for the pump, shell and primary switchboard panel. The unit is operated by the same crew operating the fuel-fired boilers, no increase in boiler-room force being necessary.

Leakage Losses in Hydro-Electric Plants

IN STEAM plants serious consideration is given not only to the losses that occur during the periods that the equipment may be in service, but also to those that may be incident to apparatus being out of service. The coal required in the operation of a boiler plant may be divided into two parts—that which is burned when the boilers are delivering steam and that burned during banked periods. In a well-operated steam plant attention is given not only to maintaining high efficiency when the boiler is in service, but also to keeping to a minimum the coal burned during the banking periods. When the over-all efficiency of the plant is considered, every pound of coal burned must be taken into account whether used in actual power production or otherwise.

How different in the average hydro-electric plant! When the turbine gates are closed and the rotor comes to rest, either in a normal manner or by applying brakes, which in some cases must remain applied to prevent the wheel from turning due to the leakage through the gates, it is not uncommon for the operator to give no further thought to the machine until it is again started and put into service. The water that runs to waste through the turbine gates during the period of shutdown is accepted as if it were the inevitable in the plant's operation with little consideration to the possible saving that could be made by closing the penstock valve or headgates. In many low-head plants the absence of the proper type of power-operated gates makes it impossible for the operator to close and open them even if he wanted to. The savings that could be made by closing these gates when the turbines are not in service would pay a handsome dividend on the investment required for the power-operated type where there is use for all available water.

There are not only the leaks that occur during the time that the turbines are out of operation, but those that take place during operation around the runners' seals. These may be comparatively small when the machines are first put into operation, but after a time these passages may become greatly enlarged from erosion, corrosion or other causes. Unless careful check is kept on the turbine's operation, these losses may become comparatively large without anyone being aware of the conditions. All the losses are not through or around the turbines; to these must be added those that occur around the flashboards, sluice gates and the water that spills over the dam during the night or other periods, if the pond has not been drawn down low enough to take care of the run-in, when the plant is shut down or operating at part load.

One cubic foot of water per second wasted for one year under a one-hundred-foot head is the equivalent of a power output, which, if sold at only one cent per kilowatt-hour, would amount to over six hundred and fifty dollars. Although this is not a large sum, it shows what these losses may amount to if the leakage becomes considerable. With the exception of those through the turbine seals the losses can, to a large degree, be prevented by the operating crew in the properly designed plant, with little or no expense. Where there is a market for the power, as is usually the case, the water above the power house is worth real money just as coal is at a steam plant, so why throw one away any more than the other?

A Suggestion for Conserving Resources

THERE has been much discussion of late regarding improved cyclic efficiencies for central power stations. So far, apparently, little or no consideration has been given to the beneficial effects that might be obtained through broadening the cycle. The more progressive industrial plants have long recognized the importance of this plan. Industrial process and power steam production as a whole, is utilized so as to obtain a high over-all plant efficiency.

If the heat diagram of the best possible ordinary central-station operation be examined, the enormous quantity of heat that is rejected to condenser discharge cannot escape notice.

Ordinarily, it represents roughly the total heat in each pound of steam at one-half pound absolute, which, after making allowance for moisture at exhaust and recovery for boiler feed of heat in condensate, is about nine hundred B.t.u. Through the use of multiple heaters, bleeding steam from main units and other devices, this waste may be decreased eight or ten per cent, but the quantity is still large.

The washing process in a worsted finishing plant can make use of all this heat down to that of water at about 106 deg. F., rejecting only some 74 B.t.u. per pound. Many other industrial processes, such as those used in pulp, cellulose and paper making, mechanical manufacture, bleaching, dyeing, textile finishing and factory heating, use steam at moderate initial pressures through an approximately similar range.

Why not plan a super-station to form the center of a group of great industrial units of the type that requires for long periods, large quantities of this relatively low-pressure steam?

Let the central station expand its service, furnishing not only the entire power and light for these industries, but also steam for their every use. Most of this could come from non-condensing units in parallel with the standard condensing ones and furnish a large part of the total power generated. Pipe-line systems would thus be kept short and less complex than in the present large industrial plant.

All modern super-stations require complete systems of both rail and water transportation. These could be

expanded at relatively unimportant added cost to provide for the entire industrial group.

There would be little that is really new or untried, except the idea of a group of varied interests working together for a common purpose. The possible savings in energy, labor, fuel and investment through the use of such a combined system are certainly large.

Whether it could be made workable depends on the possibility of securing due recognition. This must be made advantageous and profitable to all parties concerned, including both the industrial plants and the central station.

Some consideration, at least, of these possibilities would seem well worth while.

The High Cost of Machinery

RECENTLY, the management of a factory decided to install a fuel-oil system in the power plant. The equipment consisted essentially of a storage tank, pipe lines, oil heater pumps and burners. The price quoted by several manufacturers did not differ materially, but was about three times the rough estimate that the management had employed in studying the subject. In fact the lowest bidder's price was more than the boilers cost when installed a few years ago. The natural deduction was that the bids were excessive

If a bidder was expected merely to supply a definite list of equipment, undoubtedly the bid should be the sum of the market prices of the several parts. But in the sale of engineering equipment the bare market value of the machinery is but one of the items making up the total price to be quoted. Frequently, the most expensive element in such sales is the engineering services the purchaser expects to receive from the equipment man. If the factory management in question had investigated the time consumed by the manufacturer's salesman or engineer in investigating the plant's status and the time to be used later in teaching the plant force how to operate the system satisfactorily, the quotations would no doubt have seemed reasonable.

This question of when and how much engineering service is to be expected from the seller by a purchaser is a vital one. Too often thousands of dollars are wasted through the time spent by a dozen equipment firms in investigating and drawing up plans for some plant improvement. A result of this time-honored custom is an enormous amount of duplicate effort, the cost of which must be borne by the particular prospect, or by the next one if the former purchases elsewhere. That the practice entails unreasonable costs must be conceded, and if prices are to be reduced a new procedure must be established.

Logic demands that the purchaser furnish the engineering information needed. In many instances this means the employment of outside consulting engineers. But since there would be no duplicate investigation, the cost of engineering and equipment would be much below that prevailing under the present system. The second course is for the management to turn to the power-plant engineer or executive for the outlining of needed improvements. There is no excuse for the engineer in charge of a modern plant not being in possession of such information, and if he does not possess it, he should display some activity in collecting it. The equipment manufacturer should not be imposed upon, and his services should be the supplying of the machinery called for.

Legislate on Facts Rather Than Expediency

AS THE time for election approaches, there are being introduced into Congress, numerous bills calculated to enhance the popularity of Congressmen with certain groups of their constituents at the expense of Uncle Sam's pocketbook, and it is difficult for one to distinguish the purely political measures from those that possess some merit. One of the bills now receiving widespread attention, because of the character of the service concerned, is the proposal to increase the salaries of postal employees. A brief statement of some of the facts will therefore assist in formulating an opinion.

In the first place, contrary to general belief, the Post Office Department is not self-sustaining; in fact, the deficit this year will run over thirty million dollars. Undoubtedly, there are several contributing causes, among which are believed to be the tremendous increase in franked matter from Congress and various government departments and the carrying of parcel post and certain classes of mail at too low rates. To what extent each contributes to the deficit is not known, and in order to determine this on a scientific basis, Congress last year voted a half million dollars for a thorough study into the cost of service for each of the several classes throughout the country. Fifty picked inspectors have been engaged for some time upon this investigation, and it is expected that their work will be finished within the next two months.

Prior to 1920 Post Office employees were notoriously underpaid. At that time, however, the Government Reclassification Act went into effect, providing for a general salary increase among government employees, and the salaries of carriers and clerks were fixed, ranging at a minimum of fourteen hundred dollars and increasing with length of service to eighteen hundred dollars. Higher salaries were provided for special clerks. The records of the Post Office Department show that only five per cent of its employees are in the lower grade, whereas over two-thirds are in the higher grade.

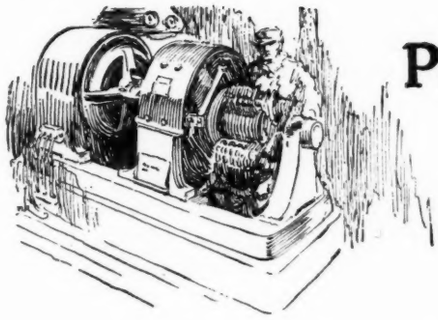
Statistics show the cost of living to have receded over twenty-five per cent from the high point of 1920.

A survey of the salaries paid by several private corporations, the duties of whose employees are comparable to those in the Postal service, shows the government pay to at least equal that of the private companies.

According to Postmaster General New the bill now before Congress would produce an estimated deficit of one hundred and fifty million dollars in the Post Office Department for next year.

It may be desirable to increase the pay of postal employees in certain localities where the cost of living is high, in spite of the foregoing figures. One of the defects in the present bill is that it applies to the country in general without taking into account those sections wherein the cost of living is greater.

As a matter of business administration a department of the government, such as the Post Office, should at least carry a balanced budget with the receipts equaling the expenditures. The investigation into cost of service now being made will in another two months show wherein the government is sustaining a loss and will thus form a basis for adjusting postal rates to an equitable basis. Therefore it would be inexpedient to pass legislation hastily until an intelligent analysis of the situation is available in order to ascertain from what source the additional funds would be forthcoming.



Practical Ideas *from* Practical Men

Useful Pipe-Fitting Kink

To engineers whose stock of supplies or spare parts is limited, the following pipe kink may be beneficial.

When removing close nipples there is always more or less damage done to the nipple by the wrench; if not destroyed entirely, in many cases it is forced out of round to such an extent that it will not make a tight joint again.

I have invariably saved the nipple and kept it round and true by screwing a fitting on it before using the wrench. The fitting acts as a protector and tends to prevent the nipple being crushed by the wrench.

This advantage may be clearly seen by any engineer, but better understood and appreciated by the man who has had the misfortune to destroy his last close nipples in this way.

Other methods used to advantage are the inserting of a wooden plug or filling the nipple with lead, but this should be found necessary only in extreme cases.

Winnipeg, Man., Canada. C. RYE.

Some Pointers on Using Formulas

We have come to be a people that use practically every labor-saving device that we can profitably employ. We use automatic machines and hire cheap operators to run them, but we must have an expert somewhere so that if anything goes wrong with the machine it can be readily repaired.

Scientific men have derived a great many formulas for solving engineering problems, and by simply taking the right formula and using it correctly the ordinary engineer can accomplish wonders. The greatest mistake is usually made in the selection of the formula and not in its mathematical solution. Therefore you must study and obtain a knowledge of the different formulas and the symbols used in them, when their values represent the condition with which you are dealing and when they do not. If you see a g in a formula and you know that the force of gravity does not enter into the problem, be careful because it is an almost sure bet that you do not want anything to do with it. A wild guess in most cases is as good as the results obtained by using a formula the symbols of which are unfamiliar. Do not try to memorize a formula; learn the value of the symbols used and how they function, and the solution will take care of itself.

Suppose we wish to know the velocity of a point at any given time. By looking in the handbook we might find these formulas, $V = at$, $V = gt$, $\omega = \phi t$, all of which mean that velocity equals the acceleration times the time. Thus we have three different symbols for acceleration—two for velocity and one for time. These are simple formulas, but they are very important, and a brief review of the terms may be helpful to those who may be hazy on them.

Velocity is often confused with the term speed. Speed is the rate at which a body approaches or recedes from a fixed point in its path, while velocity, accurately speaking, includes direction as well as speed. Suppose we say that velocity is the rate of change of position in a given direction. The last four words in that definition tell the whole story. Unless we establish firmly in our mind the fact that direction must always be associated with velocity, the full value of the definition is lost.

Acceleration is the rate of change of velocity and involves both change of velocity and the time interval in which the change has been effected. Now let us see how this works out. We can have cases where there is no velocity and yet we have acceleration. We can have a constant linear velocity and yet have acceleration. It looks as if someone had slipped up on that definition, but let us look back and see the results of the warning in the preceding paragraph and why we should heed it. Suppose that a rock is thrown vertically upward with a velocity of 64.4-ft. per sec. at a given instant and at a height of 64.4-ft. from the starting point the rock comes to rest and starts back to the earth. During its upward journey the velocity was decelerated at the rate of 32.2-ft. per sec. due to the force of gravity. Therefore when the rock paused in its upward flight, the force of gravity being constant, it changed direction at the rate of 32.2-ft. per sec. although its velocity was 0. Therefore our definition still holds good.

Now consider the case of a point having a constant linear velocity and yet having a constant acceleration. Suppose we take a point on the rim of a pulley and at a certain linear velocity in the direction of a path at right angles to the radius. Let the pulley rotate a part of a revolution, the linear velocity will be the same as before, but the direction of the path of the point has been changed; therefore, since we have changed direction, we have acceleration although the linear velocity remained constant. In this particular case angular velocity and angular acceleration should both be considered.

When using the formula $V = at$, the values for both a and t must be given because linear velocity is meant in this case, whereas if $V = gt$, only the value of t must be given because g is the acceleration due to the force of gravity and for 45 deg. north latitude, 32.2-ft. per sec. is near enough. Probably no other symbol has so many different values attached to it as the one representing the acceleration due to gravity, owing to the fact that the pull varies slightly for all changes in latitude. BURTON W. WHEELER.

Rockland, Mass.

Testing Circuits Before Working on Them

One of the dangers to which a person working on high-tension oil switches is subject, is the possible severe shock due to a static discharge after the switch has been opened and cleared from the busbars. Another and a greater danger is that a feeder may not have been cleared at both ends; that is, it may be disconnected by the operator at the power house, but for some reason, generally due to a misunderstanding of orders or location, be still alive from the opposite end.

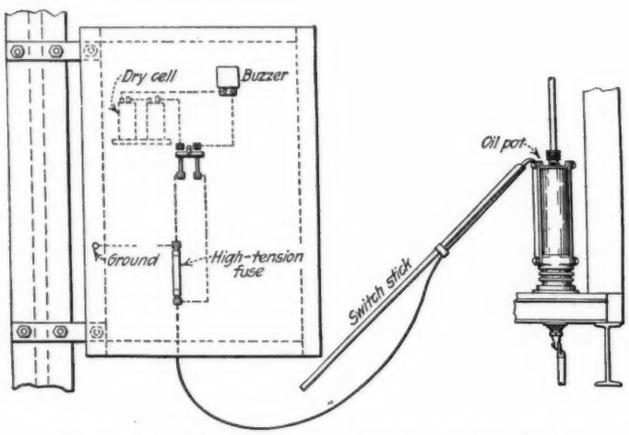


Diagram of high-tension circuit testing device

It is the usual practice to place a ground and short-circuiting jumper on the oil pots or the legs of a feeder when they are out of service. This protects the workmen who may be employed thereon, should the oil switch be accidentally made alive. The operator who places these jumpers, must, unless he has some testing device, rely on the other fellow's work that the feeder is cleared and safe.

The apparatus shown in the figure is a device by which a switch may be cleared of static; it will also indicate to the operator if a feeder is still connected to a source of potential. It consists of a buzzer, two dry cells, a double-pole switch and a high-tension fuse mounted on a panel; and a pole terminating in a metal point to which a suitable length of wire is attached. The panel is fastened to a framework of angle iron, which is fastened to some iron or steel beam in the vicinity of the feeder. Its operation is as follows:

The buzzer, when the switch is closed, is connected through the battery to the fuse and will indicate if the latter is in good condition. If the fuse proves all right, the switch is opened. The operator then takes the switch stick and touches each oil pot or leg of the feeder until all indication of static has ceased being discharged through the fuse to the ground. The double-pole switch is closed again and the fuse tested; if found to be blown, an inquiry and investigation should be made before proceeding further. Should an oil pot or leg of a feeder be touched that may not have been cleared from the bus, the blowing of the fuse will warn the operator.

This simple and inexpensive device is useful where power is received from outside plants and where the factory plant electrician may be called upon to clear a feeder. In large central stations a device similar to that shown in the figure is used, although somewhat more elaborate. The fuse should be of the kind used in high-tension cutouts, as one of low capacity may be blown by a heavy static discharge, thereby causing a false alarm, which, however, would be on the safe side.

New York City. THOMAS F. MCCANN.

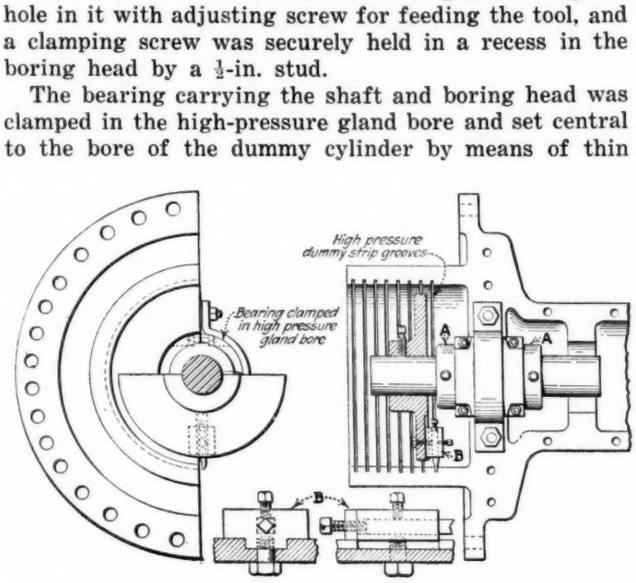
Boring Tool Removes Wrecked Dummy Packing

In a 3,000-kw. steam turbine of the combined impulse and reaction type the failure of the blading in the low-pressure stages caused the distortion of the rotor, resulting in damage to the blading in a number of the high-pressure stages, also the fouling of the high-pressure dummy against the packing strips. The fouling of the dummy piston damaged the strips to such an extent that complete replacement was necessary.

The grooves in the top and bottom halves of the dummy cylinder were $\frac{1}{16}$ in. wide and $\frac{1}{4}$ in. deep. It was found that a chisel would calk the brass strips into the groove instead of lifting them out. To overcome this, it was decided to make up a boring head so that the greater part of the strip could be cut out of the groove and the remainder extracted by a fine chisel.

A bearing was made in two halves and bored out to fit a 4-in. shaft which had been trued up in the lathe. It was then clamped to the shaft and the outside diameter turned $\frac{1}{16}$ in. less than the bore of the high-pressure gland, this reduction of diameter allowing the bar to be set central with the bore of the high-pressure dummy by inserting thin packings at either of the sides or under the bearing. Two loose collars *A* with setscrews held the shaft from moving endways. The tool-holder *B* consisted of flat stock having a $\frac{1}{4}$-in. square hole in it with adjusting screw for feeding the tool, and a clamping screw was securely held in a recess in the boring head by a $\frac{1}{2}$-in. stud.

The bearing carrying the shaft and boring head was clamped in the high-pressure gland bore and set central to the bore of the dummy cylinder by means of thin packings; the collars *B* were adjusted on the shaft to prevent any side movement when the tool, which was 0.050 in. wide, was in the center of the groove. The tool was revolved by pulling the boring head around by hand and adjusting the feed of the tool through the setscrews, each revolution. Great care would have been necessary to avoid breaking the tool and enlarging the grooves had this work been done on the lathe.



Arrangement of boring bar and head for removing dummy strips

New York City. H. T. MELLING.

Comments from Readers

Information Desired on Oil-Engine-Driven Equipment

I would like to hear from engineers who are operating oil-engine-driven refrigerating and ice-making plants and oil-engine-driven electric plants. I desire most, information regarding the makes of engines and compressors and the methods used in starting and running them.

I am seeking this information for my own benefit and can assure the writers that their replies will be treated confidentially. R. G. SUMMERS.

56 Stone St., Rochester, N. Y.

The Salesman as an Educational Factor

I read with interest the article by C. A. Harris in the March 4 issue, entitled "The Salesman as an Educational Factor." His reference to the salesman as a specialist in his particular line deserves further illumination.

There are a great many men today engaged in selling engineering equipment, who are more than specialists in their line. Many of them are graduate engineers of varied experience who have forsaken "straight engineering" to enter the sales field. Here they have found a more broadening line of activity with a greater financial return for their efforts. These men in many cases have come from plants where they have had a great deal of experience. They are able to deal with the application and operation of equipment in an intelligent manner.

I know a number of engineers who have held responsible positions in industrial plants and have gone into the sales field and have been highly successful. Men of this type bring more than the mere specialist's experience to the plant engineer. They have good sound engineering judgment and at the same time practice the profession of selling on a high and ethical plane.

In this big broad field of engineering endeavor they are known as sales engineers. SAMUEL GROSS.

Philadelphia, Pa.

Early Corliss Pumping Engine

In my article entitled "Early Corliss Pumping Engines," in the Feb. 19 issue, a portion of the test data compiled by Prof. J. E. Denton was inadvertently omitted, and while it may be rather late to give those data in detail, a few of the important results may be of interest.

Professor Denton's object in making this test, as fully reported in the Transactions of the American Society of Mechanical Engineers, Vol. XI, was, firstly, to determine the value of steam jacketing and, secondly, to verify the extraordinary duty performed by the pumping engine the previous year. As the report of the water commissioners of the City of Pawtucket for 1888 gave an annual duty of 123,656,000 ft.-lb., which exceeded a former test by several million foot pounds, it was desired to get some data that had not been obtained in previous tests. The test conducted by Professor Denton in the early part of 1889 gave a duty of 124,720,000 ft.-lb. or an increased duty of 1,064,000 ft.-lb. Some of the results obtained during the test were as follows: Steam per hour per indicated horsepower of steam cylinders, 13.64 (subject to a possible error of 3 per cent); water evaporated per pound of fuel from 102 deg. into steam at 125 lb. pressure, 8.88 lb.; equivalent evaporation from and at 212 deg. per pound of combustible, 12.12 lb.; duty per 100 lb. of coal at actual efficiency of boilers, 124,720,000 ft.-lb.; coal per hour per indicated horsepower of steam cylinders, 1.54 lb.

Much might be written on this subject that would doubtless be interesting as well as instructive, but as the complete details and results of the test can be had in the publication referred to, it seems unnecessary to repeat it here. W. H. ODELL.

Brooklyn, N. Y.

In his article in the Feb. 19 issue, Mr. Odell quotes Mr. Keene in part—as saying, "Heat will not radiate readily through a vacuum." This statement is directly opposed to a fundamental law, and I should like to submit as a substitute, "Heat energy transfer through a vacuum does not obtain, except by radiating energy waves." Convection and conduction of heat energy is impossible in the absence of matter; that is, in a vacuum. In a vacuum, energy is radiated from body to body at a specific velocity and without loss during transit. The presence of matter would reduce rather than increase the radiation loss. If the jacket had been packed with a good heat insulator, the results would probably have been better than that obtained with a vacuum. E. C. WESTCOTT.

Sacramento, Calif.

Recognition Follows, Not Leads, Service

The foreword in the Feb. 12 issue was read with a great deal of interest, as it is timely and to the point. But there is another side to the matter.

One of the most discouraging things the younger set of engineers has to contend with is the antagonism from within. By this I refer to the men on the shift jobs who have to work against others of a different frame of mind and in a great many cases of inferior intelligence. By way of explanation I cite the following experience:

I was formerly the night engineer in a plant and I had to work against a day engineer who deliberately loaded all he could onto the night man. We were supposed to leave at least enough coal out for each other to get a decent start with, but I had to get out my own coal the first thing each night. I can truthfully say that I never played that trick on him. I could see no reason for doing it. Another trick was to leave the lubricators empty and the oil pot full of cold oil. Such

little petty acts as these will give any man who tries to be a good engineer a hard feeling toward his partner. It also tends to make the other fellow slight the job to get back at his partner.

The only way to overcome this is to do your work in the proper manner and let the other fellow look out for himself. Then, there is what I term the obstinate chief engineer. There are a few of them to be found in almost every city. Sometimes an engineer who is working under a chief discovers wasteful methods and knows how to stop them and thereby save the company considerable money, if he could get his ideas across to the chief. But what can he do if the chief is one who lets those under him know who is boss in no uncertain terms?

In a plant where I was once employed there was a large amount of hot water discharged into the sewer every day from the overflow of the heater, while cold water from the city line was run into the pump suction to prevent the pump from getting steambound. When I suggested a practical method of stopping the waste, the chief replied, "Let it stand." So it is not always the operating engineer who is at fault.

Rochester, N. Y. R. G. SUMMERS.

Blowoff Cocks and Valves Give Long Service

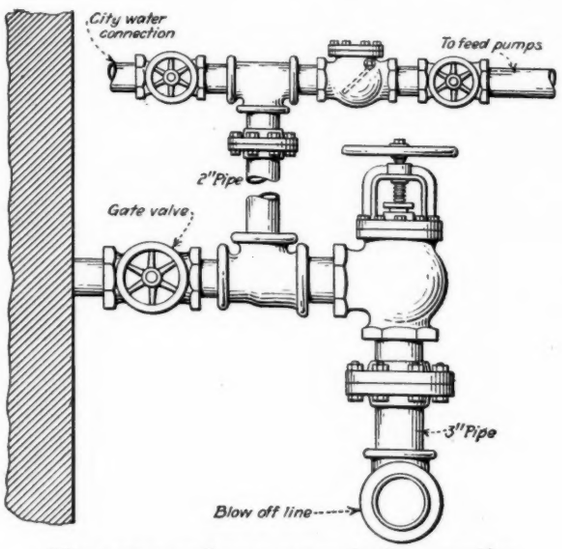
The article by W. H. Wakeman in the Feb. 12 issue, entitled "Blowoff Cocks and Valves Give Long Service," was read with interest. I doubt if a better record for long service could be shown. This long service for an unprotected blowoff pipe is undoubtedly due to its size (4-in.). It would seem that the circulation would be strong enough to prevent mud or scale from settling in it and in this way prolong the life of the pipe. Most boiler inspectors, I think, would advise against using a blowoff pipe for this length of time without replacement. In my opinion the blowoff valve and arrangement of piping is one of the most important parts of the boiler, and no doubt many engineers can recall accidents that have happened with more or less serious results through the failure in some way of a blowoff valve or piping.

Some years ago I took charge of a plant where the blowoffs were arranged in the simplest manner, having only one valve for each boiler and all of them leaking more or less. When the boilers were washed, we always had trouble with mud and scale stopping up the blowoff pipe, and the only way we could get them open was to go outside the boiler room and, with a swab on a rod, ram the blowoff pipes to get them open. This was a disagreeable task, especially in winter with the thermometer registering around zero, so we decided to get away from this condition at the first opportunity.

The boilers, which were of the horizontal return-tubular type, had only one feed connection, that being through the front head with the pipe extended inside of the boiler to discharge the water just below the tubes about two-thirds the way back from the front head. This feed pipe gave us trouble at certain times of the year by filling up with hard scale, and it was necessary to renew the pipe at frequent intervals.

In order to provide a more reliable blowoff valve arrangement and in addition, a convenient means of blowing out or clearing the pipe when washing boilers, new valves, piping and fittings were ordered and the boilers were all equipped as shown in the illustration.

A 2½-in. gate valve is used next to the boiler. This is followed by a 2½x3x2-in. tee and a 3-in. angle valve with the pressure from the boiler on the top of the disk. When blowing down, the valve next to the boiler is first opened wide, then the blowing is done with the angle valve. The increase in the size of the pipe reduces the velocity of the water passing through the 3-in. valve. By using the angle valve in the position shown, the water and scale are diverted away from the disk instead of against it. To the outlet of the tee between



City water and emergency feed connection made to boiler blowoff

the two valves the emergency boiler feed and city water are connected as shown.

If the blowoff should clog while washing the boilers, it is readily cleared by closing the gate valve and opening the valve to the city water or the boiler-feed line.

Libby, Mont. FRANK E. BATEMAN.

Burning Small Sizes of Anthracite

Referring to A. A. Cary's remarks on "Burning Small Sizes of Anthracite," in the Feb. 26 issue, the full and complete answer to his wonderment as to why Coxe built a chain-grate stoker for burning small-sized anthracite is short and definite—ash removal.

While all the objections urged against the chain grate for burning anthracite are in a measure justified, Mr. Mumford's paper showing the progress made by an intelligent investigation of some of the gas-distribution problems and the practice of the builders of the Coxe stoker in their recommendation of rear arches for the last three years, show that these difficulties can be reduced to a negligible point if not entirely overcome.

Applying Mr. Cary's own method of observing the operation of a hand-fired furnace and then improving on it, let us see what happens with the spreading method of firing anthracite buckwheat on a flat grate. The fireman, having cleaned the fire, spreads the remaining ignited fuel thinly and as evenly as possible over the grate, fires lightly over the whole grate and puts on the air. Repeating this for two, three or at most four hours, he finds that he now has two or three inches of ignited coal on top of four to eight inches of porous

clinker. which, while not fused in a glassy mass, is sintered together to such an extent that no shaking grate will cut it out uniformly over the whole area without excessive loss of fuel to the ashpit, and considerable manual labor in pushing back fires and breaking up and pulling out clinker, is required. This clinker is most conveniently disposed of by arranging the dead plate just inside the door to drop, then the clinker can be raked through this directly into the ashpit. The remaining fire is then spread over the grate and the cycle repeated. This job of cleaning fires, with the fireman unavoidably exposed to the full radiation of the furnace, is by far the hardest part of firing, yet from the nature of the fuel it is practically unavoidable with overfed fires of anthracite buckwheat. First, in contrast to Eastern bituminous coals, in which the ash seldom exceeds 15 per cent, the anthracite ash forms a bony skeleton for the lump and since the percentage of ash seldom falls below 15 per cent, it gives a much larger quantity of refuse both in weight and bulk to dispose of. Second, owing to the combustion of buckwheat taking place almost altogether in a thin, closely packed fuel bed, rather high temperatures are developed which sinter the ash together into a porous slab underlying the whole fuel bed, which is not broken up or moved back by ordinary reciprocating grate bars, in contrast to bituminous ash, which is broken up and kneaded by the rocking of the fires into much smaller masses of greater density. The only way to get rid of it, therefore, seems to be to remove it bodily from the grate as described in hand cleaning or to move it and the grate together into another zone of the furnace where it can be separated from the grate and disposed of, as in the chain-grate stoker.

Considerable has been written regarding the advantages of sprinkling stokers, but my experience with them is that they are particularly subject to the objection Mr. Cary urges against the Coxe—the amount of skilled adjustment required. They are essentially a small grate area proposition, as it is obvious that the difficulties of securing uniform distribution of coal will increase directly, if not more rapidly, with the ratio of the distances the fuel must be thrown to cover the nearer and farther portions of the grates. The argument of the use of sprinkling stokers in England and Europe is of little weight, as it is well recognized that their operating conditions and equipment are more comparable to what was used here fifteen years ago, but that in spite of ample supplies of skilled labor their boiler-room efficiencies do not compare with representative American results. A more reliable indication of the value of sprinkling and chain-grate stokers is the relative number of installations in this country, as whereas the sprinkling stoker has been tried out and proved a comparative failure, particularly for operation at high capacity, the chain grate has given excellent results.

No one denies that results equaling chain-grate stoker performance have been obtained in hand firing No. 1 buckwheat on shaking grates; in fact, the New York Edison Co. had such a system some years ago that gave remarkable results, but it had to be abandoned on account of labor costs. However, this does not justify Mr. Cary in predicting such optimistic results from his sprinkling stoker.

As a method of *a priori* reasoning I would recommend to Mr. Cary, as a substitute for his formula, the following: What are the essential conditions to obtaining the result desired, and then, how has accumulated human experience up to the present shown how to satisfy these conditions and what methods has it proved unworkable?

There has been pretty steady work on the combustion of small anthracite for the last twenty years, and the two outstanding requirements for successful operation at high capacity and economy have proved to be a uniform fuel bed with uniform distribution of air in proportion to the fuel, and to keep the fuel bed undisturbed during combustion. Assuming reasonable mixture of the coal, no more uniform fuel bed could be formed than by depositing a layer of uniform thickness on the top of a belt traveling at a uniform speed. To insure uniform distribution of air, in addition to reliance on the resistance of the layer of coal, the openings in the grate should be so proportioned as to form orifices, which, if the resistance of the coal bed decreases owing to a slightly more rapid burning out at some points, the flow of air will be limited to a fixed maximum and not concentrated at this point to the detriment of flow through the remainder of the grate.

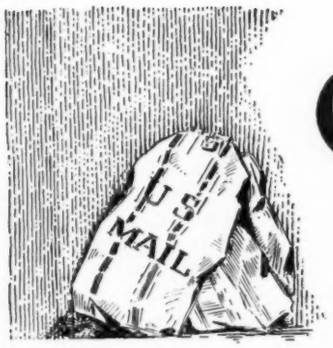
But we are burning a very high-ash fuel, and if this ash is allowed to accumulate the fuel bed will lose its uniformity and increase its resistance. So. turning to the experience of Western engineers who are of necessity working with high-ash non-coking coals, we find that they all discover that the chain grate will handle coals so high in ash and moisture that they cannot be burned successfully otherwise. Therefore, we decide taking advantage of others' experience, that some form of chain grate having a suitably reduced air space and partitions or dampers to prevent loss of wind pressure at the rear end will satisfy not only the foregoing requirements, but also that of leaving the fuel bed undisturbed, and as has been proved in practice, have developed an apparatus that will feed the coal and remove the ash without human assistance other than regulation, which cannot be said for other forms of stokers burning anthracite—all of which require hand cleaning or some hooking and slicing of clinkers, etc.

While the ignition of anthracite may be somewhat slower than with some bituminous coals, the amount of water vapor evolved is no more than with midwestern coals nor is the mechanism of ignition greatly different, so that it is hard to see why, just because it is possible to use overfeed firing of anthracite without excessive smoke, chain-grate firing should be so thoroughly condemned.

With the ordinary natural-draft chain-grate firing of bituminous coal there is the same great variation of composition of gases from front and rear of the grates, and with the large amount of air passing up through the refuse on the rear of the grates complete combustion usually occurs because there is so much excess oxygen present that the CO_2 seldom runs over 10 or 11 per cent. Similar variations can be found in overfeed and underfeed stokers, but especially in the latter furnaces are so high that complete mixture can occur before reaching the tubes. The same remedy is available for the chain grate or a modification of it as suggested by Mr. Mumford's paper, so that it seems ridiculous to abandon a well-tried and worked out method.

New Haven, Conn. H. D. FISHER.

The Ford Motor Company is building between 60 and 70 turbines ranging in size from 30,000 to 750 kw., all for its own use. The principal power station at River Rouge is intended eventually to contain eight of these largest units.



QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Use of Regular Pressure Gage for Evaporative Test

In making an evaporative test of a boiler, is it necessary to use a special pressure gage, or may the regular gage be employed? *R. N. T.*

Gages belonging to a plant may be used provided they are compared after the test with a standardized gage for appropriate corrections of the readings. The gage used during the test should be protected by proper siphons or water seal. There should be no leakage at the gage cock, and the gage should be so located that it will not be unduly heated. In making comparisons with a standard, both gages should be at their respective normal temperatures, and due allowance must be made for the head of water that was standing in the gage connecting pipe as used and as compared.

Balanced Slide Valves

What are the advantages and disadvantages of balanced slide valves? *R. B.*

The construction and operating mechanism of a balanced slide valve is almost as simple as that of a D slide valve. As the steam pressure on the opposite sides of the valve is nearly balanced, the friction and wear are less than with a D slide valve; the valve is not so badly distorted by temperature differences on its surfaces as the D valve, and compensation for wear is automatic, or may be readily adjusted by distance pieces. However, the balanced slide valve has the disadvantages of the D slide valve in that the ports are opened and closed slowly, causing wiredrawing or throttling of the steam especially at cutoff; admission, cutoff, release and compression are not independently adjustable; cylinder clearance volumes must be as large; while steam leakage is likely to be greater than with plain D slide valves.

Saving from Increasing Feed-Water Temperature

Our boilers are operated under 110 lb. pressure and the feed water is heated by exhaust steam to the average temperature of 120 deg. F. What percentage of fuel would be saved from use of an exhaust-steam feed-water heater that would heat the feed water to 210 deg. F.? *W. L. G.*

A pound of steam at the pressure of 110 lb. gage, or 125 lb. per sq. in. absolute, contains 1,190.3 B.t.u. above 32 deg. F., and when generated from feed water at 120 deg. F., each pound of the feed water must receive 1,190.3 + 32 — 120 = 1,102.3 B.t.u. If the temperature of the feed water is 210 deg. F., or 210 — 120 = 90 deg. higher, the heat required per pound of the feed water would be 90 B.t.u. less. The heat then required for generation of a given amount of steam would be the same as if the boilers were called upon to furnish (90 × 100) ÷ 1,102.3 = 8.1 per cent less steam at the stated pressure. Assuming the same boiler efficiency the coal saving would be in the same proportion during operation of the boiler, but the saving would not apply to coal required for starting and banking fires.

Place for Safety Valves on Steam Kettles

We have a number of steam-jacketed kettles each provided with one ¾-in. inlet and one ½-in. outlet, and the kettles should be protected against steam pressure higher than 80 lb. gage. Should each kettle have a safety valve on the inlet, or the outlet, or should the safety valve be connected directly with the steam jacket? *W. W. J.*

The safety valve should be capable of preventing a building up of pressure higher than the pressure safe for the steam kettle. For that purpose it is best if the safety valve is placed on the supply connection between the supply stop valve and the steam jacket, and is of sufficient size to discharge the fullest capacity of the connection between the supply stop valve and the safety valve. Aside from the fact that the ½-in. outlet is smaller than the inlet, a safety valve should not be placed on the outlet, as connection with the safety valve might become obstructed; and for a like reason it is better to place the safety valve on the steam inlet than to have it connected directly to the steam jacket.

Moisture per Pound of Air

In computing boiler and furnace efficiency, how is the amount of moisture per pound of air calculated? J. M. P.

The amount of moisture per pound of air supplied to the furnace can be found by multiplying the weight of vapor contained per pound of air of the given temperature when saturated by the relative humidity prevailing at the time of the test. The relative humidity, or percentage of saturation may be obtained from the weather reports or by means of a psychrometer, and the weights of moisture that would be present in atmospheric air saturated with moisture at various temperatures, as determined by computations and experiments, are quoted in most engineer's handbooks and works on physics.

The weight of water in saturated air at different temperatures is as follows:

Temp., Deg. F.	Pounds of Vapor per Pound of Air	Temp., Deg. F.	Pounds of Vapor per Pound of Air
0	0.00092	72	0.01680
12	0.00155	82	0.02361
22	0.00245	92	0.03289
32	0.00379	102	0.04547
42	0.00561	112	0.06253
52	0.00819	122	0.08584
62	0.01179	132	0.11771

Noisy Check Valve on Vacuum Heating System

When an electrically driven vacuum and boiler feed pump stops, what causes the discharge check valve to close with a bang? The check valve is located near the pump, with about thirty feet between check and boilers. This annoyance occurs with six to twelve pounds pressure on the boiler side of the check and three to ten inches of vacuum on the other side of the valve. S. H.

The valve is suddenly closed by the boiler pressure forcing the water back toward the pump, in which there is a partial vacuum when the power is shut off. The sudden reversal of pressure would be reduced by having an air chamber connected with the run of a tee in the pipe on the boiler side of the check, with the check valve connected to the side of the tee, and the noise would be further reduced by having a larger check valve, as it would not be opened so wide when the pump is running.

Testing Equality of Cutoff Without Indicator

How can equality of cutoffs of a Corliss engine be tested and corrected without the use of an indicator? J. D. A.

To test the equality of cutoffs, block up the governor to the medium running height. Then with the wrist-plate hooked up to the eccentric, turn over the engine slowly by hand in the direction it is to run, and when the cutoff is detached by the cam, measure on the slide the distance the crosshead has traveled from dead center. Then recontinue turning the engine and note where the other valve is tripped. If cutoff is equal, the distance traveled on the slides will be the same. If it is not equal, adjust the governor reach rods until the points of cutoff become the same. If the cutoff cams are connected and both are operated by a single reach rod from the governor to the crank-end valve cam, first adjust the cutoff of the crank-end cam by lengthening or shortening the governor reach rod and afterward make the head-end cutoff agree with the cutoff of the crank end by adjusting the length of the connection between the cams.

Determining Percentage of Moisture in Coal

Using the ordinary facilities of a power plant, how can a fair determination be made of the percentage of moisture contained in coal delivered? C. R. J.

The percentage of moisture is difficult to obtain mainly on account of the trouble and expense of securing a test sample that is fairly representative of the whole shipment. Ten- to fifteen-pound samples should first be taken from all parts of the shipment and preferably during the time when the coal is being loaded or unloaded from the wagon, car or vessel in which it is transported. As coal rapidly absorbs or gives off moisture, according to the humidity of the atmosphere, the original samples as taken up should be placed in covered receptacles and thoroughly mixed as soon as possible in a space that is protected from rain, snow, wind and direct sunlight. Then a sample of about 20 lb. of the mixture should be taken as representative of the average moisture content to be determined from loss of weight by drying the test sample. As soon as the test sample is separated, its weight should be determined on a scale that is sensitive to about ¼ oz. After weighing, the coal should be spread out on a sheet-iron tray and exposed to a temperature of about 250 deg. F. for several hours, taking care to protect the sample from strong drafts which might blow away some of the dry dust; and it is advisable to cover the tray with a perforated sheet-iron cover, leaving a space of an inch or two between it and the coal. For the purpose of drying, the tray containing the sample may be placed on a flue or boiler breeching, but must not be allowed to get too hot or some of the combustible volatile will be distilled off, thus giving an erroneous result. The sample is to be carefully weighed after drying for about four hours and then weighed every hour afterward until two consecutive weighings agree. The loss from the original weight before drying, multiplied by 100 and divided by the weight before drying, is the percentage of moisture.

Diagrams from Two-Stroke-Cycle Semi-Diesel Engine

Figs. 1 and 2 are light spring diagrams taken from the two cylinders of a two-stroke-cycle semi-Diesel engine. Why are the expansion lines wavy, and why does the pencil line in Fig. 1 drop below atmospheric pressure when the piston uncovers the ports? A. C.

The wavy lines are due to vibration of the indicator mechanism. With regard to drop below atmospheric

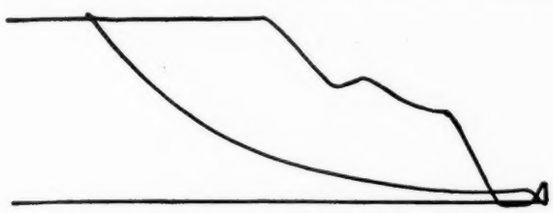


Fig. 1—Cylinder pressure drops below atmospheric pressure

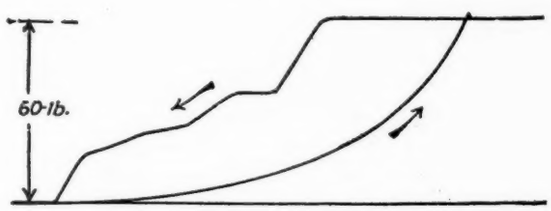


Fig. 2—Wavy expansion line

pressure, when the piston uncovers the exhaust ports, the gas charge passes out through the exhaust line. If this exhaust pipe is of a proper proportion, the pressure wave set up will cause the pressure at the exhaust port to be less than atmospheric when the ports are uncovered at end of the next power stroke. The rise in pressure at the foot of the diagram, Fig. 1, is due to the exhaust-pressure wave traveling back along the pipe and so builds up the pressure. The reversal of the wave is shown by the sharp drop in the line at the end of the stroke. The reason Fig. 2 does not show the same characteristics in the exhaust period may be due to a different proportion of its exhaust pipe.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

The Bourdon Gage

ONE instrument, at least, is found in every boiler room, however poorly equipped. That is the boiler steam gage. Similar gages are used on air tanks, oil lines and for a hundred other purposes. The basic element of practically all such gages is the "bourdon tube," a flattened and curved tube closed at one end. When pressure is admitted through the open end (which is held stationary), this tube tends to straighten out. The result is a small movement of the free end, which is magnified through a system of levers, links and gears to give a considerable movement to a hand on a graduated scale. A gage of this type is shown in Fig. 4.

The fact that a flattened tube tends to straighten out when subjected to internal pressure can be proved by a simple experiment. A thin-walled copper tube may be partly flattened, bent in an arc and then connected to a source of pressure as shown in Fig. 1. Admission of pressure to the tube will cause it to uncurl a little, so that the free end moves an appreciable distance. The chief cause of this phenomenon is to be found in the fact that when pressure is admitted to a tube of flattened or elliptical cross-section, it becomes more nearly round. If the original cross-section of the tube were like the upper left-hand sketch in Fig. 2, the pressure might widen it out to a form like that shown in the lower sketch.

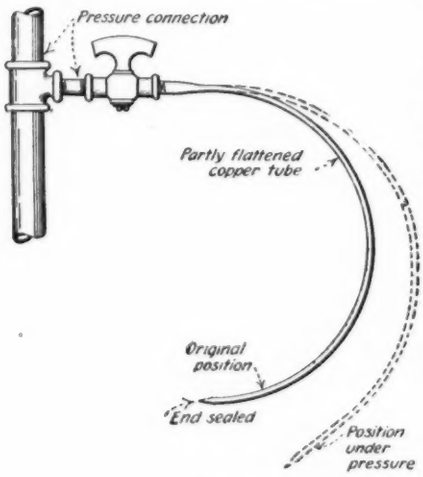


Fig. 1—Pressure straightens flattened tube

It will be noticed that the dimension *A* which increases is the thickness measured in the same plane as the curve of the tube. Now the inner arc of the tube is necessarily shorter than the outer, the difference between the two lengths, together with the thickness, determining the degree of curvature. For a given total length of tube and a given difference in length between the inner and outer arcs, the thicker the tube the less will be the curvature.

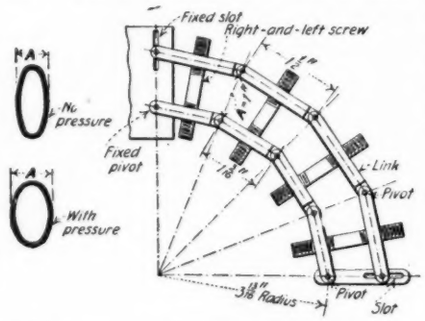


Fig. 2—Tube compared to a model

Left—Effect of pressure on tube cross-section. Right—Model to illustrate straightening effect.

That this must be true can be shown very clearly by the model of Fig. 2 and Fig. 3. This is a sort of double chain, each section consisting of an outer link 1½ in. long and an inner link 1 3/16 in. long. The distance between the inner and outer lengths can be adjusted by right-and-left screws, one for each pair of links. The pivot-and-slot arrangement at the left corresponds to the stationary support for the bourdon tube, while the group of links corresponds to the tube itself, the thickness being represented by the distance between the outer and inner links.

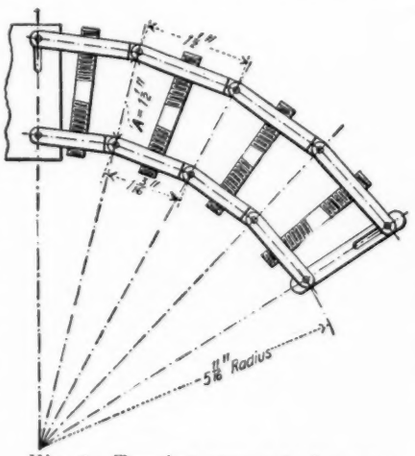


Fig. 3—Turning screws to increase A straightens model

Any variation in the distance between the outer and inner links immediately changes the curvature of the group. For example, in Fig. 2, with a distance of 1 in. between the inner and outer links, the inner curve of the "tube" has a radius of 3 13/16 in. Increasing the distance between the inner and outer links obviously tends to straighten out the "tube." When this distance reaches 1½ in., the inner radius is increased to 5 11/16 in. as shown in Fig. 3.

In addition to this change in curvature due to the filling out of the tube, there are other slight distortion effects which may occur even with a round tube. These, however, are not important at the pressures found in steam plants.

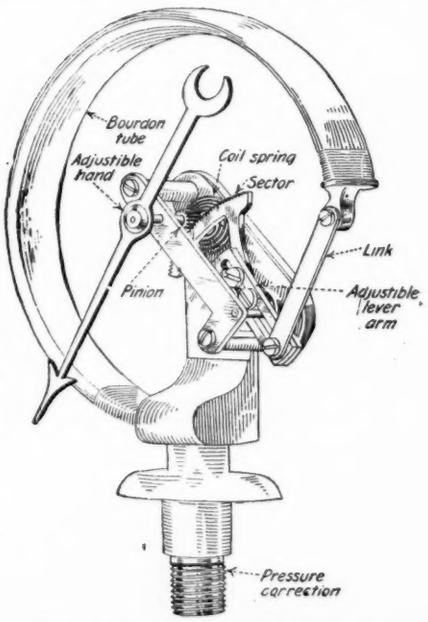


Fig. 4—Mechanism of steam gage

The action of the tube having been explained, the general operation of the gage shown in Fig. 4 can be seen without difficulty. As the pressure rises, the tube starts to uncurl, which moves the free end up and toward the right. This acting through the link, moves the adjustable arm of the sector. The gear teeth on the other arm rotate the pinion connected to the indicating hand.

On account of the importance of the steam gage as a safety precaution, the testing and adjusting of these gages is usually left to the manufacturers, boiler inspectors, or others specially skilled in this work. It is essential that steam gages read correctly in the range of working pressures. Accuracy at lower pressures is desirable but not so essential.

New and Improved Equipment

Automatic Electric Combustion Control Equipment

An essential to efficient power-plant operation is some means of automatically controlling the rate of combustion in the boiler furnace to meet the load demands. One of the latest electrical equipments for doing this is known as the Thermogen combustion control and is the product of the Thermogen Equipment Co., Inc., Brooklyn, N. Y. This apparatus can be used to control the stack damper on a single boiler or on a bank of hand-fired boilers, or it may be made to control the stoker and fan speeds on a bank of mechanically stoked boilers and also regulate the dampers. The initial impulse in the operation of the regulator is given by the steam pressure, which is allowed to vary over a small range according to the load on the boilers.

In Fig. 1, which shows one of the latest developments in this equipment, boiler pressure is applied to diaphragm *P*, which is loaded through lever *L* by the spring *S* and a weight attached to the compound lever at *W*. The loading of this diaphragm is adjusted to correspond to the minimum steam pressure at which it is desired to operate the plant, say 148 lb. when the average pressure is 150 lb. Pointer *H* is attached to *L* and is caused to move over the contacts 1, 2, 3, 4 and 5, and close the circuit of motor *M*. The motor is geared to the threaded shaft *T*, which as it is moved allows the position of the damper to change or adjusts the controllers on the stoker and fan motors. As shown in the figure, the equipment is in the position for minimum steam pressure, say 148 lb., and the damper wide open. An increase in pressure to 149 lb. will cause pointer *H* to move to the right and roller *R* to close contact 2, starting the motor and closing the damper a given amount, when further movement is stopped by roller *D* coming in contact with switch *b*, opening it and stopping the motor. If the steam pressure continues to rise, say, to 150 lb., arm *H* will be caused to move to the right, close contact 3, start the motor and close the damper to a new position, when its movement will be stopped by roll *D* opening contact *c*. Should the pressure decrease, lever *L* will take a lower position, and in doing so will cause pointer *H* to move back on contact 2 and at the same time close the mercury-contact reversing switch at *N* and cause the motor to reverse, start opening the damper and speeding up the fan and stoker motors, if used. When roll *D* comes in contact with switch *b*, the circuit is opened and the movement stopped, until another change in pressure causes further movement of the diaphragm *P*.

From the foregoing it will be seen that regulation of the damper position and the speed of the fan and stoker motors are obtained in definite steps to meet the change of load on the boilers. Switches *a* and *e* are placed at the two extreme positions of the damper and give maximum and minimum stoker and fan speeds. However, these two points are never reached except at sustained light or maximum loads on the boilers. Switches *b*, *c* and *d* are placed so as to be within the normal operating range of the boiler, and it is over these three points that the regulator operates, except for extreme load conditions. These points are adjustable and can be arranged after installation of the regulator to meet best the need of the load on the plant. Stack and grate area, stack height and average power loads are all taken into account in establishing the position of these points. With the machine operating on a variation of 4 lb. in pressure, say from 148 to 152, it will not necessarily close the damper one-fourth with a change from 148 to 149 lb. in steam pressure, or one-half with a change to 150. The draft at position *a* might be 1 in. (148 lb.); position *b* might reduce the draft to 0.5 in, *c* to 0.4 in., *d* to 0.3 in., and *e* to 0.1 inch.

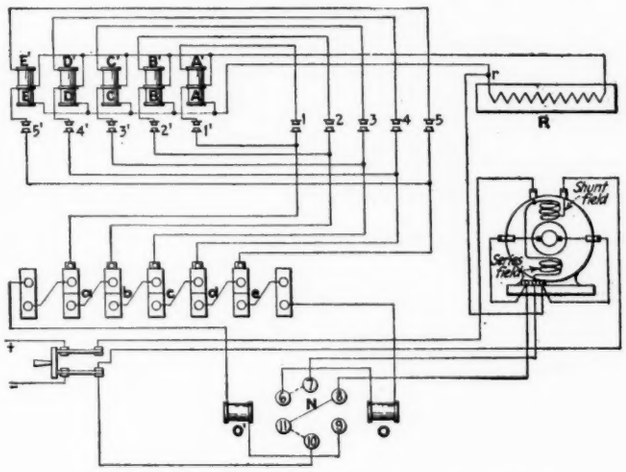


Fig. 2—Diagram of regulator connections

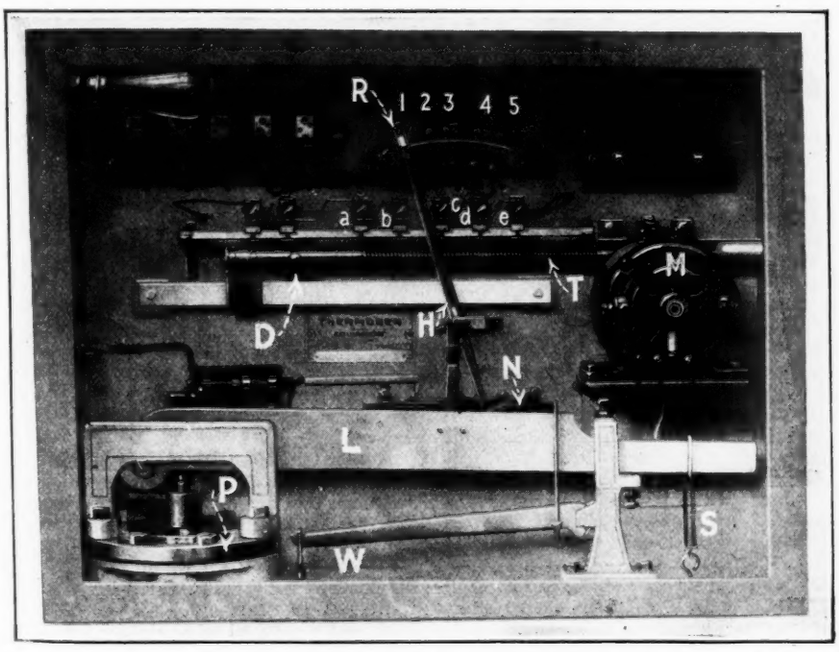


Fig. 1—Assembly of damper regulator

To make the operation of the regulator more clear, reference is made to the diagram Fig. 2. Contacts *a*, *b*, *c*, *d* and *e* are normally closed, except when opened by movement of shaft *T* in Fig. 1, and contacts 1, 2, 3, 4 and 5 are normally open except when closed by movement of pointer *H*. The contacts of relays *A*, *B*, *C*, *D* and *E* are in parallel in contacts 1, 2, 3, 4 and 5 and hold the circuit closed until the motor completes the adjustment indicated by closing of any one of contacts 1, 2, 3, 4 or 5. The mercury contact

reversing switch *N* is arranged so that contacts 6 and 7 and 11 and 10 may be closed at one time, or 7 and 8 and 9 and 10 may be closed when the others are open. Assume that contact 3 is closed and that the reversing switch has been closed to the position indicated by the dotted lines. The shunt-field circuit of the motor is connected directly to the line and is energized at all times. Closing the contacts and reversing switch completes a circuit through the motor's series-field winding, contacts 6 and 7 on the reversing switch through coil *O*, limit switches *e*, *d* and *c* to contact 3, through coil *C'*, resistance *R*, the armature of the motor, contacts 10 and 11 on the reversing switch and to the — side of the line. Completing this circuit starts the motor. Simultaneously with starting the motor, coil *O* is energized and holds the reversing switch closed as long as the motor circuit is energized. Current flowing through coil *C'* causes it to close contacts 3', which shunts contacts 3 out of circuit, energizes coil *C* and shunts resistance *R* out of the motor circuit, so that when this occurs the motor circuit, instead of being through contacts 3, is through contacts 3' coil *C* to *r* terminal on resistance *R* and directly to the motor. Coil *C* holds contact 3' closed and the motor circuit complete even if contact 3 should open by a further movement of pointer *H*. The motor continues in motion until the adjustments are made that were indicated by contacts 3 closing, when the circuit is interrupted by the opening of contacts *c*. Normally, the regulator is designed for 5 points of control, but when conditions require, 7 points may be furnished.

Time-Delay Overload Relay That Cannot Close by Vibration

A new type of induction time-delay overload relay has been placed on the market by the General Electric Co. The

Time delay overload relay

contact mechanism of this relay is of an improved design, which prevents the contacts from being closed by vibration or jar. A target is provided to indicate that the relay has operated.

The stationary contacts are two phosphor-bronze flexible fingers with silver tips. Carried on the gear that meshes with the pinion on the disk shaft is a silver plate which bridges the two contact fingers and closes the contact circuit. The gear carries a small armature, which is attracted and held by a coil in series with the contact circuit, thereby insuring good contact until the tripping circuit is interrupted by some external means. As further assurance of good contact the silver tips are intentionally made small that the unit pressure may be high.

A white enamel target which shows that the relay has operated is included with the contact mechanism. Normally, it is out of sight behind the time index plate, but is raised into view by the plunger of a coil when current flows in the tripping circuit. Once raised, it remains in sight until reset by a push button on the front of the relay cover.

The Borsig Valve

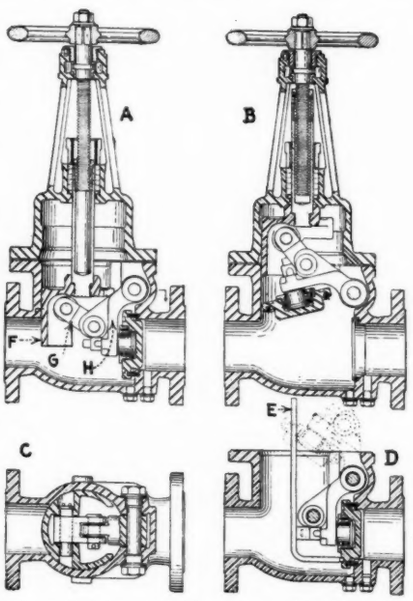
A type of globe valve in which the disk is withdrawn completely from the flow of steam was briefly mentioned in the Dec. 11, 1923, issue. Space at that time did not permit a comprehensive description of the construction, which allows regrinding with the disk in place, packing the main gland with the valve wide open, and means whereby a uniform speed of the spindle will result in a progressively slower closing action of the disk. This valve is made by the Borsig Works in Germany. It is being introduced by the Techno Service Corporation, of New York. The manufacturers are extensively engaged in building locomotives and other mechanical equipment and have spent many years in the development of the practical operating features of this valve.

The closed and opened positions are indicated at *A* and *B* in the figure. The crosshead *F*, shown in section at *C*, is raised or lowered by means of the exterior valve stem, which in turn is operated by means of an interior threaded shaft turned by the handwheel. The toggle link *G* is pivoted to the crosshead as well as to the lifting lever *H*. It will be seen in the wide open position at *B* that maximum speed of disk closing results from the leverage between the crosshead and the disk. As the disk approaches its seat, however, the leverage changes so that the speed of the disk decreases continually as the crosshead approaches the position at *A*. Therefore, a uniform speed of the spindle will produce a graual slowing up of the disk speed in closing.

The exterior valve stem contains a valve disk on top of the crosshead which completely closes the gland in the bonnet against steam leakage when in the open position, as at *B*. This makes it possible to pack the valve when wide open.

The valve may be reground as at *D* by removing the bonnet as well as the crosshead. A gooseneck wrench at *E* can be inserted, so that it pivots on the lifting lever *H* and enters a hole in the disk. The disk can be reciprocated through a short travel for regrinding. There are a number of holes in the disk so that the wrench may be inserted from one to the other in regrinding.

For very heavy pressures, however, the steam should enter at the left so that it will tend to seat the valve, which may be of benefit in case of an emergency where quick closing is desired. The work required in opening will be somewhat less, as in this case the thrust will be taken by the pivot



Straightway valve may be packed when open

on the lifting lever *H* and in the other case the thrust will be exerted against the crosshead, resulting in considerably more friction.

The large diameter of the packing gland and exterior stem tends to promote rapid cooling of these parts by the air. In case of wear of the valve or opening mechanism, washers may be inserted between the disk and the holding pivot. Provision is made for attaching a motor drive.

World's Record for Petroleum Production in 1923

The American Petroleum Institute estimates the world's petroleum production in 1923 at 1,010,995,000 bbl., compared with 854,809,000 bbl. reported by the United States Geological Survey for 1922. The increase in 1923 amounted to 156,186,000 bbl., or 18.3 per cent.

The United States produced 735,000,000 bbl. in 1923, or 72.7 per cent of the total world production. In 1922 the United States produced 557,531,000 bbl. or 65.2 per cent of the world production in that year. The increase in the United States production in 1923 amounted to 177,469,000 bbl. or 31.8 per cent.

Mexico produced 149,472,000 bbl. in 1923 or 14.8 per cent of the world production. In 1922 Mexico produced 182,278,000 bbl. or 21.3 per cent of the total production in that year. The decrease for Mexico in 1923 amounted to 32,806,000 bbl. or 18 per cent.

In 1923 the United States and Mexico combined produced 87.5 per cent of the world production, and in 1922, 86.5 per cent.

Power-Plant Auxiliaries and Heat Balance*

By A. L. Penniman, Jr.†

IT WOULD seem that the greatest opportunity for economy lies in the use of power from the main unit for auxiliary drive, this power being applied as directly as possible, together with the use of the maximum economical amount of low-temperature steam bled at several points from the main unit. The question now arises as to whether this scheme provides the essential flexibility and ease of operation.

By the use of motors it is possible to obtain compact drives, eliminating reduction gear troubles and a mass of auxiliary piping. Where direct-current motors with field control for speed variation are used, there is no appreciable decrease in economy of the drive with decrease in speed. When properly designed ball bearings are used, practically no attention is required and the units may be started, stopped or the speed varied from remote points.

Air Removed in Hotwell

When the extra storage of boiler water is in the hotwell of the condenser and the makeup is admitted at this point, it is feasible to keep the water in the hotwell at the temperature of the exhaust steam. The temperature of the hotwell is raised by the condensate from the lowest-temperature feed heater, plus some additional steam bled from the last stage of the main turbine when necessary. This eliminates the use of deaërating apparatus and makes possible the location of the makeup float valve so that it is readily accessible to the condenser attendant, who also looks after the boiler-feed pumps. The division of duty between the hotwell pumps and boiler-feed pumps can be so arranged as to allow minimum water pressure on the closed heaters compatible with reliable operation. The hotwell pump can be run at constant speed, the total speed variation being taken care of by the boiler-feed pump.

Stage bleeding together with electric drive offers opportunity for higher efficiency with a maximum of flexibility at a cost as low or lower than with any other form of auxiliary drive. It only remains to provide an arrangement for obtaining power from the main units in such a manner as to guarantee continuity of auxiliary power supply, eliminating all chance of trouble on the main bus being transmitted in any manner to the auxiliary bus.

All power-plant auxiliaries fall into three general classes with respect to the necessity of their having a continuous power supply. First comes equipment that does not require a continuous power supply, such as coal- and ash-handling equipment, circulating-water screens, sump pumps, machine tools, etc. This class of equipment can be eliminated from the present discussion.

Secondly, there are auxiliaries that are needed only when the station is carrying load and that have to be shut down in case of an interruption that greatly reduces the plant load. To this class belong forced- and induced-draft fans, while coal-feed and clinker-grinder drives might well be included, as they are normally supplied from the same circuits that supply the fans. It is essential to check the fires as soon as a general interruption occurs, so it is an advantage to have fan motors trip out due to low voltage. Where automatic starting panels are used, the service is automatically restored as the main-bus voltage comes back. In actual practice following a general interruption, the normal station load does not come back immediately after the restoration of service. This allows ample time for furnace conditions to become normal.

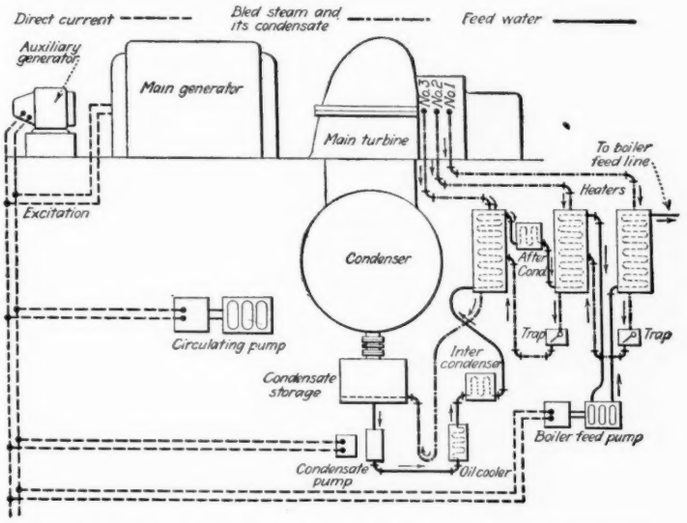
Third, come the auxiliaries, which must be kept in service at all times. These include the exciters, boiler-feed pumps and circulating pumps. Where the boiler-feed makeup storage is a part of the condenser hotwell, it is also essential that the hotwell pumps be kept in service.

The service for this third class of auxiliary drive can be most economically and advantageously supplied by a separate generator connected directly to and driven by each of the main turbine units.

Direct-connected exciters have been in fairly general use for a number of years and have been so satisfactory that there seems to be no reason why the size of this piece of apparatus should not be increased sufficiently to take care of the additional load imposed by the so-called essential auxiliary drives. This auxiliary generator can be relatively small, in fact about 2½ per cent of the capacity of the main unit. This arrangement will require, as does the direct-connected exciter, some auxiliary source of power for starting up. This can be taken care of by a motor generator supplied from the house service transformers, which, if necessary, can be equipped with a non-condensing turbine exhausting to atmosphere, for starting up in case of a complete shutdown of considerable duration.

Heat Balance Arrangement

The diagram shows such an arrangement for a 25,000-kva. unit. The auxiliary generator is rated at 500 kw. 250 volts direct current. A 3,000-gal. water storage will be provided in the condenser hotwell. Three-stage bleeding will be used. The condensate from the high and intermediate temperature heaters will be trapped back to the next lower-temperature heater, while the low-temperature heater condensate will be trapped back to the hotwell, where it will be used to heat the condensate and make up to the boiling point in order to drive off entrained air.



Flow chart for bled steam, feed water and direct current

It will be noted that this scheme provides auxiliary power from the most efficient source and allows of the most economical scheme of feed heating without any complications. Auxiliary wiring is on the unit principle; the auxiliaries and generator, being grouped together, do not require long runs for low-voltage auxiliary feeders, and there is no transformation loss in obtaining direct current for these drives. Careful analysis would seem to indicate that this scheme provides the necessary reliability without calling for any compromise that affects the economy of the general layout, at a first cost no greater, if not actually less, than any of the arrangements in general use, with a maximum of flexibility of operation at varying loads and a minimum number of operating attendants.

*Extracts from paper presented at the Midwinter Convention of the A.I.E.E., Philadelphia, Feb. 4-8, 1924.

†Consolidated Gas, Electric Light & Power Co., Baltimore, Md.

The Power Plant

BY JAMES EDWARD HUNGERFORD

Here in the hum of the dynamo room,
Reigns the lord of the blue-white light;
Here's where he weaves on his whizzing loom
The magic that wipes out night.
Here is the life of the city's heart,
The soul of the town athrob;
Here is his throne in the mighty mart,
Where he bosses the lighting job.

The blue flames crackle and leap and glow
On the giant wheels awhirr,
And the crooning song of the dynamo
Sets the pulses of trade apurr.
The magnets hum to the brushes' touch,
In perfect accord they fuse,
And all are held in the mighty clutch
Of the lord of the lightning "juice."

The switchboards gleam with their pilot lights,
And copper switches ashine,
That send the current adown the nights,
To twinkle along the line.
The cables of copper strands unfurl,
O'er the city to twist and creep
And set the heart of the town awhirl,
And blot out the darkness deep.

Here in the hum of the dynamo room,
Are the workers who toil at night,
To keep it spinning—the giant loom,
That's weaving the blue-white light;
Their overalls darkly splotched with oil,
Their faces begrimed with sweat,
Their muscles toughened with honest toil—
True princes of power—you Bet!

Novel Features of a Large Turbine

A 30,000-kw. turbo-generator, the largest machine so far manufactured in Great Britain, is described in *Engineering* of Jan. 18 and Feb. 1, 1924. This is designed for 200 lb. gage, total temperature 588 deg. F. and vacuum 28½ in., giving a water rate of 11.1 lb. at 25,000 kw., built by the British-Thomson-Houston Co., of Rugby, England. This contains one velocity stage two-row wheel and 13 Rateau stages.

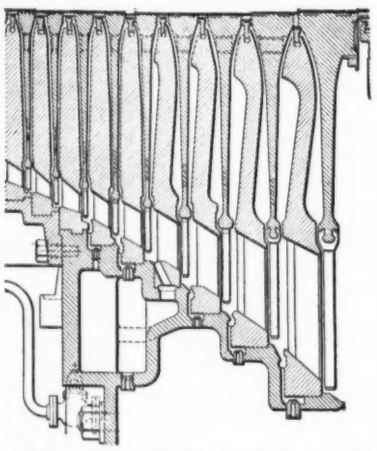


Fig. 1—Water extracted in last six stages

An interesting means of draining water from the lower stages of the cylinder is shown in Fig. 1. This represents a section of the lower wheel casing. It will be seen that each diaphragm contains a groove to catch water that is thrown off the blade by centrifugal force. Each of these grooves is drained at the bottom of the turbine casing.

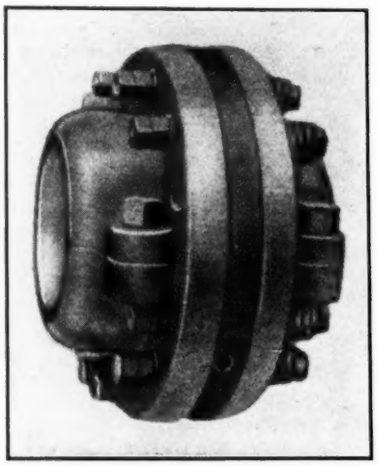


Fig. 2—Friction dampens bearing vibration

Since the turbine operates at 1,500 r.p.m. and the revolving field is designed with a critical speed at 900 to 1,000 r.p.m., a device is supplied to dampen vibration in passing through the critical speed, such as when starting up or shutting down.

This device constitutes a special bearing, Fig. 2, at the exciter end. The liner contains a central supporting flange. On each side is an auxiliary flange which fits tightly in the spherical recess of the bearing housing. These are held against the central flange by means of bolts with spring pressure. When vibration occurs, the liner is thus able to move somewhat, being restrained by the friction of the two outside auxiliary flanges. The account does not state how alignment is secured, but it is inferred that this is taken care of by the downward weight acting, so as to seat the lower part of the central supporting flange in an aligning fit.

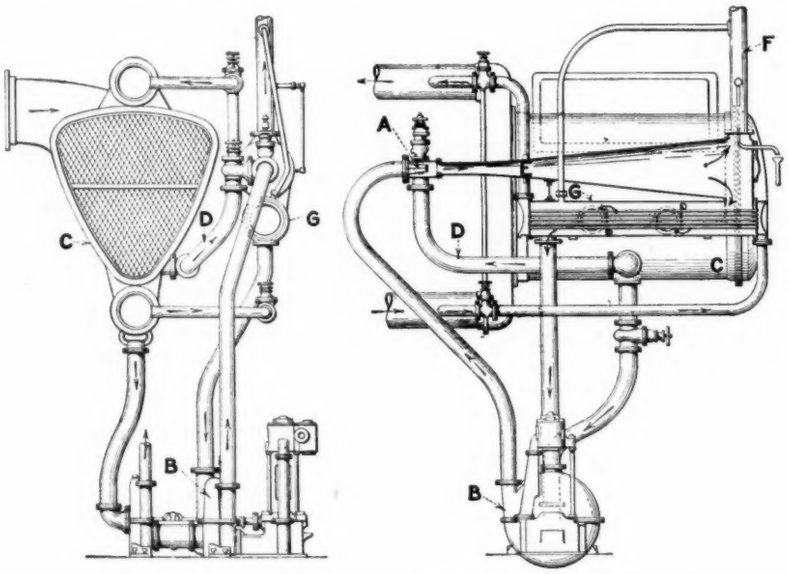
Each wheel is driven at 25 per cent above speed in a bombproof pit in the floor. Rotation is secured by playing a jet of steam against the blade.

Water-Jet Air Pump for Condenser Service

A recent issue of V. D. I. contains a description of a type of water-jet air pump that has been used extensively in central stations in Germany and is now being adapted to marine service.

The general arrangement of the jet as applied to a surface condenser is shown in the accompanying illustration. Fresh water is discharged through the nozzle *A* under a pressure of 18 to 20 lb. by the centrifugal pump *B*. The suction created by the water draws the air and vapor from the main condenser shell *C* through the pipe *D*. Upon leaving the nozzle *A* the water passes into a cone-shaped discharge pipe where the velocity of the water is reduced to a minimum and the air separates from it and passes to the atmosphere through the vent pipe *F*. The water, in returning to the pump, passes through the cooler *G* where the temperature is reduced to normal.

The cooling-water section of the small shell *G*, is connected in parallel with the main condenser, a branch being taken off the main inlet and outlet circulating water connections. In the arrangement shown, a centrifugal condensate pump is direct connected on the same shaft as the auxiliary circulating pump *B* and removes the solid water from the bottom of the main condenser.



Water-jet air pump connected to surface condenser

The output of the Belgian coal mines for January was the greatest since the armistice, exceeding 2,000,000 tons.

Rastall Will Investigate Machinery Markets

In order to gather first-hand information as to the steps that American manufacturers of machinery may take to insure their securing the maximum amount of increasing demand in Europe for industrial machinery, Walter H. Rastall, chief of the machinery division of the Department of Commerce, will sail on June 3 for a visit to Russia, Poland, Austria, Czechoslovakia and Yugoslavia.

Mr. Rastall will also investigate the extent to which importers in European countries may be induced to add an American machinery specialist to their staff, since Europe's buying power is not likely to reach a point for a long period to come which will justify manufacturers in maintaining branches.

It is believed that fundamental conditions in these countries are now such that purchases of machinery will be made as fast as the economic situation will permit, and as there is evidence that they are going to be better off, Mr. Rastall feels that first-hand information is necessary to determine exactly how the market is to be reached under changed conditions. Before the war the distribution of machinery in these countries was handled through German agents; it is now in the hands of Swiss and French firms.

Ontario's Hydro Investigating Committee Reports

The commission that has been investigating the Hydro-Electric Power Commission of Ontario for the past two years, headed by W. D. Gregory, filed its report with the Ontario Legislature on March 13. The report summarizes all the various activities of the commission and contains the following general findings:

"The principle of the public ownership of water powers of the province and their development by the people for the people is, in our opinion, fundamentally sound and should be maintained at all hazards in its full integrity.

"The engineering department of the commission is made up of men of high professional qualifications as engineers, and as such they are serving the commission zealously and efficiently. The various plants of the commission are exceptionally well operated by them.

"The methods of accounting adopted by the commission we believe to be adequate and proper, both in respect to the manner in which the duties are apportioned and as regards the records.

"That the organization administered by the commission is financially sound there is not the slightest doubt. The commission has, to a large degree, a monopoly of something that everyone wants. Any organization that has such a monopoly should have no difficulty in paying its way, provided its method of administration is sound. To some of the practices of the commission we take strong exception in our reports, and to these reports we refer.

"The things to which we have taken exception are nearly all matters of administration."

New Development Planned

According to press reports extensive hydro-electric plans are being considered by the Ontario government. These included a Queenstown power development similar to that at Chippawa and a power development at Morrisburg. Preliminary development grants were considered for these projects, and a definite provision of $5,000,000 for auxiliary steam plants was also contained in the estimates.

The grant this year is largely as follows: $13,500,000 to go to the Niagara system, of which $100,000 is for the purpose of inquiring into the feasibility of a second canal system; $5,000,000 for steam power plants; $1,500,000 for development work at Morrisburg, the scene of the future St. Lawrence power scheme; Georgian Bay system, $1,300,000, of which $550,000 is to go to the development of power on the Muskosh River; the Thunder Bay system, $2,550,000; the Central Ontario system, $1,400,000; the Nipissing system, $180,000; the Rideau system, $100,000, and the Ottawa system, $780,000, $750,000 of which is to be devoted to development work.

Gas, Fuel Oil and Lubricant Production Decreased

According to government reports the production of gas and fuel oils in January was 1,062,892,393 gal., a slight decrease from the December output. Imports declined 7,000,000 gal., amounting to 36,471,249 gal. Exports of these oils were 109,908,000,000 gal., a decrease of 40,000,000 gal. from the December figures. The domestic demand was 977,143,731 gal., an increase of about 25,000,000 gal. over the December demand. About 12,000,000 gal. of gas and fuel oils were added to stocks, which on Feb. 1 amounted to 1,527,346,622 gal.

Lubricants established a slight decrease in production in January, the output amounting to 94,534,650 gal. Exports were 25,175,405 gal., a decrease of 8,000,000 gal. from December exports. Domestic demand for lubricants in January was 67,391,215 gal., an increase of 14,000,000 gal., or 26.9 per cent, over figures for the preceding month. Stocks of lubricants on Feb. 1 amounted to 244,755,997 gal., an increase of 2,000,000 gal. for the month.

N. Y. Boiler Inspectors to Be Graded

An act to amend the labor law, by adding section eighteen b, in relation to salaries and grades of boiler inspectors has been introduced into the New York State Senate by Mr. Reiburn. It provides for six grades of inspectors and is in effect a yearly promotion arrangement with increased salary. The salary ranges from first grade, carrying $1,680, to chief boiler inspector, receiving $3,500 a year. The act is to take effect July 1, 1924.

Topographic Maps Urged by Engineering Council

Passage of the Temple Bill, now pending in Congress and providing for the complete topographic mapping of the United States, is urged by the American Engineering Council as a step of vital importance to national development. The council has placed before President Coolidge a resolution adopted by its administrative board favoring the Temple measure, approval of which has, it was said, been expressed by Secretary of the Interior Work.

"In the industrial development of a country the preparation of adequate maps is logically the first step," said the American Engineering Council's statement made public by the president of the council, ex-Governor James Hartness, of Vermont. "To aid in the intelligent building up of our transportation system, in the development of superpower plants, in the extension of irrigation and drainage projects, an accurate knowledge of the configuration of the earth is essential."

Muscle Shoals Considered by Agriculture Committee

A session of the Senate Committee on Agriculture and Forestry is to be set aside in the immediate future for consideration of procedure in handling the bills relating to Muscle Shoals.

All members of the committee apparently are agreed that no further hearings are to be held in connection with the bid of Henry Ford, acceptance of which is provided in a bill that has passed the House.

While a majority of the members of the committee are said to be opposed to the Ford offer, it is apparent that at present there is no majority for any offer.

Proponents of the Ford offer expect to try to get the subject before the Senate without a committee recommendation and will attempt to bring the issue to a vote on the floor. Vigorous opposition to the Ford bid is expected on the floor of the Senate.

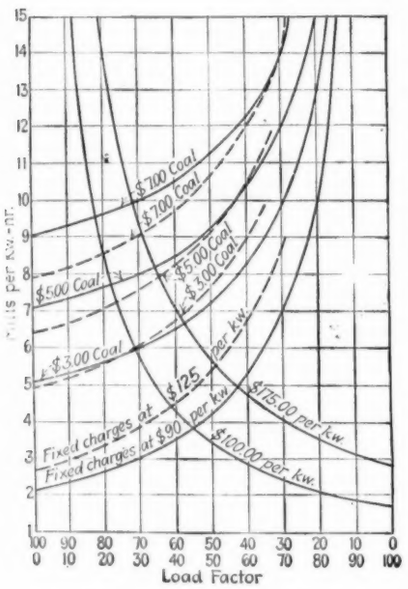
Reports on Mine Mouth Plants

Engineers on Hoover Board Find That Fuel Alone Must Be Depended Upon For Ultimate Expansion in Northeast Section

THE INTRINSIC value of mine mouth steam stations and the practicability of generating large blocks of power at the mines and transmitting it to important local centers is being shown by an analysis of the studies covered by Secretary Hoover's power survey or superpower study.

An analysis is also being made as to the extent to which undeveloped hydro-electric power may take care of the anticipated growth in demand, it being concluded in one estimate that, even with all available water power developed in the Northeast area, fuel alone will have to be depended on to take care of any increase after 1930.

Colonel Kelly of the Federal Power Commission has prepared and transmitted through Secretary Hoover to the state engineers a report, part of which consists of the two sets of curves shown herewith and the supporting data upon which they are based, as set forth in the captions.



Comparative production costs, steam and hydro

The group of eight curves pertains to steam plants; the group of two curves (marked $175 per kw. and $100 per kw.) pertains to hydro plants.

The basis on which these curves are calculated is as follows: The steam dotted-line curves are based on a construction cost of new modern high-pressure plants at $125 per kw., with a coal consumption of 1½ lb. per kilowatt-hour. The steam solid lines are based on construction cost per average plant now producing power at large load centers at $90 per kw., with a coal consumption of 2 lb. per kilowatt-hour. In both cases fixed charges are 14 per cent per annum and maintenance $6 per kw. per year, price of coal $2.50 per ton (2,000 lb.), freight and handling charge for plant at mine 50 cents per ton, storage, handling and insurance at large load center 30 cents per ton, and there is a table of freight rates from which it is possible to calculate the delivered cost of coal at any important center.

The hydro-electric power curves are calculated on St. Lawrence and Niagara power construction costs at $100 per kw. installed and local hydro plant construction cost at $175 per kw. installed, and in both cases with fixed charges of 13 per cent per annum and operation at $2 per kw. per year.

In an estimate of the comparative cost of power delivered to centers as against cost of power generated at the centers, Cleveland, Baltimore, Philadelphia, New York and Boston are considered, and, based on the curves reproduced, Table I is obtained. It is

TABLE I—COMPARATIVE COST OF TRANSMITTED AND OF LOCALLY GENERATED POWER

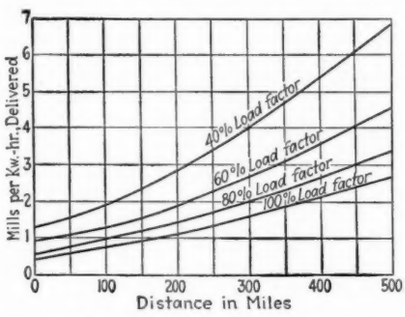
Place	Distance from Mine Plant	Transmission Cost from Mine Plant, Mills	Cost of Power Delivered from Mine, Mills	Cost of Coal, Ton	Cost of Power Locally Generated, Mills	Difference Against Mine Plant, Mills
Mine	...	....	5.6	$3.00	5.6	0.0
Cleveland	125	1.1	6.7	4.80	7.0	—0.3
Baltimore	275	1.8	7.4	5.50	7.45	—0.05
Phila.	350	2.25	7.85	5.50	7.45	+0.4
New York	425	2.7	8.3	5.80	7.7	+0.6

then stated: "When in addition the difficulties incident to high-tension transmission are considered, it is safe to say that the local plant will be favored except when a material saving can be shown. Under present conditions it is not likely that power from plants at the mine will be transmitted to distances greater than 200 miles."

TABLE II—TYPICAL ANALYSES OF ASSUMED POWER SUPPLY

	Cost, Mills
BOSTON DISTRICT:	
(Coal $6.70, load factor 38 per cent.)	
All local steam	12.3
Half local steam + sixth local hydro + third St. Lawrence	10.7
Five-sixths local steam + sixth local hydro	12.0
NEW YORK DISTRICT:	
(Coal $5.60, load factor 40 per cent.)	
All local steam	11.1
Two-thirds local steam + third St. Lawrence	9.8
Seven-eighths local steam + eighth local hydro	11.0
Half local steam + half plant-at-mine steam	11.1
PHILADELPHIA DISTRICT:	
(Coal $5.50, load factor 40 per cent)	
All local steam	13.6
One-half local steam + one-half plant-at-mine steam	10.8
Two-thirds local steam + one-third local hydro	9.7
BALTIMORE DISTRICT:	
(Coal $5.50, load factor 40 per cent)	
All local steam	10.8
One-half local steam + one-half plant-at-mine	10.5
Two-thirds local steam + one-third local hydro	9.7
CLEVELAND DISTRICT:	
(Coal $4.80, load factor 40 per cent)	
All local steam	10.1
Half local steam + half plant-at-mine steam	9.5
Two-thirds local steam + one-third Niagara power	9.0

The above stated figures show the desirability of developing all the principal hydro-electric power possibilities in the region under consideration. In this connection it is interesting to note that for the year 1935 the estimated installation in this region is 34,500,000 hp. whereas the developed and undeveloped hydro power for 50 per cent of the time flow is estimated by the Geological Survey to be 9,700,000 hp., or a little over 25 per cent of the total. If the hydro were developed it would, because of the base load which it carried, furnish about 50 per cent of the total kw.-hr. production of the year 1935. Another interesting point developed by the data is that the remaining undeveloped hydro in the Northeast area about equals the estimated growth of the load in that



Cost of transmitting power at various load factors and distances

area between now and 1930. In other words, in a few years coal alone will have to be relied upon for supplying the increased demand for power.

Junior Engineers Wanted

Examinations for junior engineer will be held by the United States Civil Service throughout the country on May 7 to fill vacancies in various branches of the government service at entrance salaries of $1,860 a year. Full information may be obtained from United States Civil Service Commission, Washington, D. C., or at the post office or custom house in any city.

Canada Declares National Coal Policy

Canada by a motion passed in the Canadian House of Commons, Ottawa, March 31, practically adopted a national policy in relation to its coal supply. The matter was brought to the attention of the House through a motion of T. L. Church, of Toronto North (Conservative), to the effect that it was time for Canada to have a national policy as regards coal; that no part of Canada should be left dependent on the United States for its supply of fuel; that the Government should initiate an all-British and Canadian supply, carrying it on a preferential toll basis and placing a duty on American coal.

Throughout his address Mr. Church continually drew attention to the fact that the Dominion possessed 20,000 miles of national railway and a large merchant marine and yet nothing was being done to bring the immense coal reserves of the Maritime Provinces and Alberta into central Canada.

The *New York Times* had said quite rightly that it was time that Canada looked after its own coal supply. In order to do this, freight rates should be so regulated as to encourage movements of coal from one part of Canada to the other and the tariff raised to shut out coal from the United States.

One Thousand Horsepower Solid-Injection Oil Engine

Several years ago the San Antonio Portland Cement Co., San Antonio, Tex., was operating a 1,000-hp. and a 480-hp. producer-gas engine. These units were converted into solid-injection oil engines by the substitution of new cylinder heads, oil-injection pumps and other parts. Although built to operate at low pressures, in operation it was shown that the far higher pressures occurring with the solid-injection cycle caused no distress. So satisfactory have the engines functioned that a 1,000-hp. Ingersoll-Rand solid-injection engine was purchased and lately placed in service to carry the increase in plant load.

Another Interconnection Effects Four States

Details of a $46,000,000 program of hydro-electric development were announced recently by the Penn Public System of the Pennsylvania Electric Corp. which is erecting three dams and power stations as part of the program on the Clarion River, in Clarion County, Pa., according to press reports. The plant is expected to be ready for operation by June. The project is known as the Piney Development. It was started in 1922 as the smaller of three projects on the Clarion which will cost $28,000,000.

The other part of the program takes in the Youghiogheny River in Garrett County, Md. There, 2,400 ft. above sea level and "at the top" of the Alleghenies, the first of four dams and three power stations are under construction, at a cost of about $18,000,000. The plants will sell power to the Penn Public System and to other wholesale customers.

Both plants will add a closely connected series of hydro-electric developments to a chain of subsidiary companies operating properties from Maryland across Pennsylvania to New York on the north and Lake Erie and Ohio on the northwest. These properties, more than a score in number, are owned by the Pennsylvania Electric Corp. More than 300 communities of varying sizes and industrial importance are served.

Tennessee River Has Large Power Possibilities

The House Rivers and Harbors Committee has agreed to include in the new rivers and harbors bill, on which it is working, an authorization for a survey of the Tennessee River from Riverton, Ala., to the juncture with the Ohio, the cost being estimated at $315,000. No appropriation will be made until next year. The survey will be both for purposes of improvement of navigation and for possible sites for hydro-electric development. Representative Gordon Browning, of Tennessee, in urging the committee to approve the survey, declared that the power possibilities in the lower Tennessee River are even greater than those at Muscle Shoals.

N.E.L.A. Plans Scientific Lighting Campaign

The National Electric Light Association is planning an educational campaign for the dissemination of scientific knowledge on good illumination and the conservation of eyesight through proper diffusion of light in the homes and schools of the nation. To this end the Lighting Educational Committee of the N.E.L.A., at its executive meeting at Chicago, March 13, appointed a committee that will have as chairman, James E. Davidson, Omaha, Neb., vice-president of the N.E.L.A., to further this campaign. The details of the plan have not been announced yet, but it is expected that they will be divulged at the spring meeting at Atlantic City in May.

The entire activity is to be non-commercial, the movement having grown out of the desire of the foremost men in the industry to give the public a better understanding of the correct principles of lighting, and will be participated in by the leading scientific societies of America.

Program Cleveland Meeting of the A. S. M. E.

MONDAY, MAY 26

Morning—Opening of headquarters and registration bureau; Council meeting.

Afternoon—Visit to Nela Park with departmental trips, sporting events, box luncheon, entertainment.

TUESDAY, MAY 27

Morning—"Power Problem of Steel Industry" (Under auspices of Power and Gas Power Divisions): "Power Organization in the Steel Industry," Bryant Bannister and F. M. Van Deventer; "Generation and Utilization of Steam for Production of Power in Iron and Steel Industry," John A. Hunter; "Use of Gas Engine in Steel Works," A. E. Danks. Windmill and Fan Design: "Performance of Centrifugal Fans for Electrical Machinery," C. J. Fechheimer; "Wind Power," F. J. Pancratz.

WEDNESDAY, MAY 28

Morning—Cleveland Power Session: "Pulverized Fuel," W. H. Aldrich; "High Pressure Pumping," L. A. Quayle; "Determination of Heat Losses Through Insulating Material by Means of Their Conductivity Coefficients," R. H. Heilman (by title).

Afternoon—Session on Mercury Vapor Process: Paper by W. L. R. Emmet. Design Session—"Protection of Steam Turbine Disk Wheels from Axial Vibration," W. Campbell; "Temperature and Stress Distribution in Hollow Cylinders," G. C. Dahl (by title); "Mathematical Theory of Dynamic Stresses in Rotating Gear Pinions," Paul Heymans.

THURSDAY, MAY 29

Morning—Topical Discussion on Materials at High and Low Temperatures (Joint Session with A.S.T.M.): "Industrial Application of Metals at Various Temperatures," L. W. Spring; "Methods of Testing at Various Temperatures and Their Limitations," V. T. Malcolm; "Available Data on the Properties of Irons and Steels at Various Temperatures," H. J. French; "Available Data on the Properties of Non-Ferrous Metals," A. E. White and H. W. Uptegrove; "Recommendations of Committee for Future Development." Joint Session with A.S.R.E.: "Temperature Measurement," P. Nicholls (contributed by A.S.R.E.); "Heat Transfer," Edgar Buckingham (contributed by A.S.M.E.).

Afternoon—Excursion to Lorain. Inspection trips through National Tube Company plants.

Babcock & Wilcox Co. Elects New Officers

Announcement is made of the selection of A. G. Pratt, formerly vice-president of Babcock & Wilcox, to the presidency in place of W. D. Hoxie, who becomes vice-chairman of the board of directors. Mr. E. H. Wells remains as chairman of the board. Isaac Harter, for many years general superintendent of the company, succeeds Mr. Pratt as vice-president.

Water-Power Projects

Kentucky River to Be Developed.—W. J. Loughbridge, of Lexington, Ky., has declared his intention to build a dam 100 ft. high in the North Fork of the Kentucky River, near Airdale, Ky. The project will be capable of developing 20,000 hp. it is estimated.

Seattle's Municipal Plant.—An ordinance authorizing the expenditure of $957,913, the balance of the eleven-million-dollar bond fund raised to construct the Gorge Creek plant of the City of Seattle, has been introduced in the Council. According to the engineer in charge this amount will complete the work and power from the plant will be brought into the city some time during May. The Council, however, has ordered an investigation of the whole Skagit hydro-electric project, of which Gorge Creek forms part, and completion of the plant referred to may be delayed. The initial development by the city will have a capacity of 54,000 hp., and plans call for an ultimate development of about half a million horsepower.

Coosawattee River, Ga.—Plans have been completed for the erection of a hydro-electric plant in north Georgia which will develop 45,000 hp. and supply energy for a new industrial section. This development, according to Dr. N. P. Pratt, of Atlanta, owner of the property, who is an engineer, will involve an expenditure of $5,000,000 before completion. Dr. Pratt says that a 250-ft. dam will be erected on the Coosawattee River at Gable's Gorge, in Gilmer County, where the river is joined by Flat Creek. The dam will be 1,500 ft. wide, backing the waters of the Coosawattee River upstream for 13 miles and creating an artificial lake of great size. The new power plant will provide a means of opening up a rich territory which heretofore has lacked electric power. Charles O. Lenz, of New York, has been retained as engineer.

Personal Mention

James H. McGraw, president of McGraw-Hill Co., Inc., has returned from Europe.

Prof. Elihu Thomson has recently been honored with the degree of Doctor of Laws by the University of Pennsylvania.

William D. Brewer, chief engineer of the Oklahoma Light & Power Company's plant at Pauls Valley, has been promoted to the position of mechanical superintendent of the company's general power plant at Byng.

James D. Cunningham, president of the Republic Flow Meters Co., is leaving for Europe on May 6. He expects to attend some of the World Power Conference meetings while over there.

R. L. Weber is a new member of the electrical division of Stone & Webster, Inc., Boston, Mass. Mr. Weber has had wide experience in the design and construction of steam and hydro-electric power stations of many types and for the past ten years has been engineer for the Kansas City, Mo., Railways Co.

Obituary

William Downes, a member of No. 25 Association of the N.A.S.E., New York, died on March 25. Mr. Downes had been recording secretary of his association for 18 years and was its president at the time of his death, as well as treasurer of the state N.A.S.E. For 35 years he has been engineer for Hornthal & Co. at 53d St. and First Ave., New York City, having come to this country from England 42 years ago. Mr. Downe was a familiar figure at state and national meetings of the N.A.S.E. for many years. Having no relatives in this country, his employer and No. 25 took charge of his funeral and interment arrangements. He was buried in St. Michaels cemetary, Astoria, L. I., on March 29.

William Henry Maw, editor of *Engineering* and a noted English engineer, died on March 19 at his residence at Kensington, England. He was born in 1838, privately educated and apprenticed soon after his sixteenth birthday to the Eastern Counties Railway Works, where he remained, finally becoming the designor of the locomotives for the East Indian Railway, until 1865, when he left this company to join Zerah Colburn in establishing *Engineering*.

Mr. Maw was president of the Civil and Mechanical Engineers' Society in sessions of 1863-64 and 1864-65; president of the Institution of Mechanical Engineers, 1901; chairman of the International Engineering Congress at Glasgow University, 1901; delivered the "James Forrest" lecture for the Institution of Civil Engineers in 1903, and was elected president of that institution in 1922; president of the British Astronomical Association 1899-1901. Besides unlimited work for the magazine and scientific and technical societies Mr. Maw maintained an independent practice as a consulting engineer, his work being largely in connection with engine and boiler construction and the design of workshops.

Society Affairs

The Milwaukee Section of the A.S.M.E. will hold its April 16 meeting at the Milwaukee Athletic Club. Dean Kimball of Cornell will be the speaker.

The Metropolitan Section of the A.S.M.E. will hold a meeting on April 24, which will be preceded by a dinner at the Building Trades Club. The subject will be "Oil Engines"; the speaker, Dr. Charles Lucke.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual meeting at San Francisco, May 12-14.

American Chemical Society. Charles L. Parsons, 1709 G St. N.W., Washington, D. C. Annual meeting at Washington, D. C., April 21-25.

American Electrochemical Society. C. G. Fink, Columbia University, New York City. Meeting at Hotel Bellevue-Stratford, Philadelphia, Pa., April 24-26.

American Order of Steam Engineers. W. S. Wetzler, 753 North 44 St., Philadelphia, Pa. Annual meeting at Moose Hall, 1314 North Broad St., Philadelphia, Pa. June 2-7.

American Society of Civil Engineers. John H. Dunlap, 29 West 39th St., New York City. Spring meeting at Atlanta, Ga., April 9-12.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at Cleveland, Ohio, May 27-29.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

American Welding Society, Miss M. M. Kelly, 29 West 39th St., New York City. Annual meeting at New York City, April 23-25.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio. Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Kansas Association** at Parsons, Kans., April 16-18. J. M. VanSant, 739 Horne St., Topeka, Kan. **Indiana Association** at Lafayette, Ind., May 5-6. Prof. A. W. Cole, Purdue University, Lafayette, Ind. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 10-12, 1924, formerly announced June 11-14.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section,** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9. **Southwestern Division.** S. J. Ballinger, San Antonio Public Service Co., San Antonio, Texas. Divisional meeting at New Orleans, April 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Hotel Statler, Buffalo, N. Y., April 30 to May 2, 1924.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

The Buffalo Section of the A.S.M.E. will have an illustrated "Trip Through the Bureau of Standards," by Hugh G. Boutell, as the attraction for its April 14 meeting.

The Charlotte, N. C. Branch of the A.S.M.E. will hold its April 11 meeting at the Manufacturers Club. George A. Orrok, New York Edison Co., will speak on "Development of Steam Power."

The Providence Engineering Society will have as the topic for its April 15 meeting, "1934 in Providence." Don L. Galusha will speak on "Central Stations," William B. Spencer on "Traction," Clifford Paige on "Gas."

The Louisville Section of the A.S.M.E. will hear B. M. Bingham, of the University of Louisville, give an "Outline and Discussion of the Engineering College at the University of Louisville," at its April 18 meeting.

The Birmingham Section of the A.S.M.E. will hold a meeting on April 11, at which the general topic will be "Education." Dr. Spright Dowell will speak on "Auburn and Its Aim for the Student Engineer"; Prof. J. M. Gallalee will have as his subject "The Engineering Graduate—His Training and Opportunity."

The Detroit-Ann Harbor Section of the A.I.E.E. and the **Detroit Section of the A.S.M.E.** will hold a joint meeting on Thursday April 17. P. W. Thompson of the Detroit Edison Power Plant will present a paper on "Trenton Channel Plant," and A. A. Meyer of the same company will read a paper on "The New 120,000-volt Transmission System of Detroit Edison Co."

The Department of the Interior, with the co-operation of the Willard Storage Battery Co., has prepared a film illustrating vividly all details in the construction of an electric storage battery, its workings and its proper care. This film will be available for distribution under the free loan service of the Bureau of Mines about April 1. Requests for the loan of the film should be addressed to the Bureau of Mines Experiment Station, 4800 Forbes St., Pittsburgh, Pa.

Business Notes

The Combustion Engineering Corp. and the **Green Engineering Co.** announce the opening of an Indianapolis office at 315 Guaranty Bldg., which will be under the management of B. J. Schneider.

W. H. Nicholson & Co. of Wilkes-Barre, Pa., manufacturers of steam specialties, have recently appointed the Ashmead-Danks Co., 7016 Euclid Ave., Cleveland, Ohio, as their district representative for northern Ohio.

Laclede Stoker Co., 4438 Hunt Ave., St. Louis, Mo., announces that it has purchased the chain-grate stoker business of the Laclede-Christy Clay Products Co., including patents, patterns, good will, etc. The new company will continue the manufacture of the Laclede-Christy stoker and gives service to stokers of this type now in use, especially furnishing repair parts and engineering.

Trade Catalogs

Service Boxes, Noark — The Johns-Pratt Co., 160 Huyshope Ave., Hartford, Conn. Leaflet describing Noark service boxes for industrial power circuit control.

Pumps—Lammert & Mann Co., 215 N. Wood St., Chicago. Booklet describing this company's line of vacuum and pressure pumps where pressure up to 25 lb. is needed.

Water Softener, Ice Plants—Graver Corp., East Chicago, Ind. Leaflet "Water Softeners for Ice Plants of 50 Tons or Less Capacity," gives numerous reasons for the use of this softener with method of operation and data on intermittent softeners.

Condensers, Static — The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Circular No. 1670, "Static Condensers for Power Factor Correction," contains besides descriptions, photos, etc., a comparison with synchronous condensers illustrated by charts and tables.

Blowers—American Blower Co., Detroit, Mich. Leaflets, "The Air of the Mountains" and "Electric Ventilation for Every Room," describe in an interesting way the use and benefits of these blowers.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Mar. 24, 1924	Mar. 31, 1924
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.50	2.35
Somerset	Boston	2.75	2.50
Kanawha	Columbus	1.70	1.70
Hocking	Columbus	1.85	1.75
Pittsburgh No. 8	Cleveland	1.90	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.85	1.85
S. E. Ky.	Louisville	2.00	2.00
Big Seam	Birmingham	2.25	2.25

FUEL OIL

New York—April 3, light oil, tank-car lots, 28@34 deg. Baumé, 5½c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—March 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2 per bbl.; 32@36 deg., gas oil 5½c. per gal.; 38@40 deg., 6½c. per. gal.

Pittsburgh—March 27, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 6c. per gal.

Cincinnati—March 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6c. per gal.; 26@30 deg., 6½c. per gal.; 30@32 deg., 6¾c. per gal.

Dallas—March 28, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—March 28, 28@30 deg., $2.31@$2.36 per bbl.; 18@22 deg., $2.10 @$2.16½; 13@16 deg., $1.68@$1.74½ per bbl.

Boston—March 24, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4½c. per gal., light oil, 28@32 deg. Baumé, 6½c. per gal.

New Plant Construction

Calif., Randsburg—H. M. Thurman and associates have been granted permission to install and operate a hydro-electric power plant on the Birch Creek Spring, to cost about $45,000.

Calif., San Diego—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids for 2,900 boiler tube brushes for the local navy yard, as specified in Schedule 2022.

Conn., Rocky Hill—The Bellamose Corporation, Hartford, Conn., manufacturer of artificial silk, will install a 1,000 hp., steam-operated electric power station at its new local mill, now in course of erection.

D. C., Washington—The Bureau of Supplies and Accounts, Navy Department, will take bids until April 22, for rotary converters and spare parts for eastern and western yards, as set forth in Schedule 2031.

Fla., Fort Pierce—The City Council is considering the installation of electric-operated pumping equipment in connection with extensions and improvements in the waterworks, for which a fund of $125,000 is being arranged.

Fla., Lake Alfred—The City Council plans for the installation of electric-operated pumping equipment in connection with its proposed waterworks plant. A steel water tank and tower will also be installed. The J. B. McCrary Co., Atlanta, Ga., is engineer.

Ga., Columbus—The Board of Public Works is reported to be planning for the installation of electric-operated pumping equipment in connection with extensions in the sewerage system, estimated to cost $240,000.

Ga., Dalton—The American Thread Co., 260 West Broadway, New York, has construction under way on its proposed local mill, to include a power house, estimated to cost $1,000,000, with machinery.

Ga., Macon—The Central Georgia Public Service Co., operated by the Central Georgia Power Co., has been granted permission to issue bonds for $2,000,000, and stock for $600,000, a large part of the proceeds to be used for the construction of the proposed steam-operated power plant on local site, with initial output of about 13,000 hp. Other units will be built later.

Ga., Macon—The General Reduction Co., Dry Branch, Ga., contemplates the construction of a boiler plant at its proposed plant on site purchased near Macon for clay mining and commercial clay production, estimated to cost $75,000. K. R. Slocum is general manager.

Ga., Sardis—The Vestal Lumber & Mfg. Co., Knoxville, Tenn., has acquired local property for its proposed mill in Georgia, and will soon begin the construction of a plant with initial output of 50,000 ft. per day, with steam-operated power house. It will cost approximately $150,000. J. P. Vestal is president.

Ill., Chicago—The National Biscuit Co., Tenth Ave. and Fifteenth St., New York, plans for the installation of a boiler plant at its proposed local four-story and basement bakery, at Polk and Lexington Sts., estimated to cost $600,000. P. G. Zimmerman, 85 Ninth Ave., New York, is architect.

Ind., Frankfort—The Frankfort Heating Co., operating a central power house and heating system, is reported to be planning for extensions and improvements, including additional equipment. The company has recently been acquired by new interests, headed by Byram C. Robbins, Richmond, Ind.

Ind., Indianapolis—The Indiana Electric Corp. is taking bids for the structural steel framework for a new steam-operated power plant, estimated to cost $250,000. It is understood that orders for equipment will be placed at an early date.

Ind., Oakland—The Oakland City Water Co. is reported to be planning for the installation of electric-operated pumping equipment in connection with proposed waterworks, estimated to cost $80,000. Bonds are being issued.

Ind., Rockport—The Rockport Pottery Co. plans for the construction of a boiler plant in connection with its proposed local pottery, estimated to cost about $75,000. G. H. Guthrie and L. N Savage, Rockport, head the organization.

Kan., Fredonia—The Board of City Commissioners will receive bids until April 14 for a municipal electric power plant and system, to include two 300 hp. Diesel oil engines, generators, switchboard and auxiliary equipment. Arthur L. Mullergren, 555 Gates Building, Kansas City, Mo., is engineer. W. O. Starns is city clerk.

Kan., Independence—The Prairie Oil & Gas Co. is reported to be planning for the construction of a power house and pumping station in connection with its proposed local refinery, estimated to cost $200,000.

Kan., Kansas City—The Kansas City Can & Mfg Co., Fourth and State Sts., plans for the construction of a boiler plant at its proposed factory in the Fairfax Drainage District, estimated to cost $80,000. Horner & Wyatt, McMillen Bldg., are engineers.

La., Baton Rouge—The Baton Rouge Rubber Mfg. Co., 17 Old Reymond Bldg., recently organized, will construct a steam-operated power house at its proposed local rubber mill, estimated to cost $80,000. M. L. Castay is president.

La., Baton Rouge—The Mengel Co., Louisville, Ky., manufacturer of boxes and other wood products, plans for the construction of a steam-operated power house at its proposed local hardwood mill, estimated to cost close to $1,000,000.

La., Baton Rouge—The Texas Chemical Co., Houston, Tex., is reported to be planning for the construction of a power house at its proposed local plant for the manufacture of sulphuric acid, estimated to cost more than $150,000.

La., Ferriday—The Fisher Body Co., General Motors Bldg., Detroit, Mich., plans for the construction of a steam-operated power house at its proposed local hardwood mill, estimated to cost $700,000.

Md., Baltimore—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., will begin the construction of a steam-operated power house at Race and Barney Sts., 48 x 95 ft., to cost about $40,000.

Md., Baltimore—The Standard Sanitary Mfg. Co., Bessemer Bldg., Pittsburgh, Pa., has contruction in progress on the initial units of its proposed local enamelware manufacturing plant on Fifth Ave., Canton section, with power plant, 105 x 132 ft., steam-operated, estimated to cost $600,000. The station equipment will be arranged to provide for service for 22 buildings, costing $3,000,000.

Mass., Holyoke—The Municipal Gas & Electric Department is awarding contracts in connetion with alterations and improvements in the municipal electric power plant, estimated to cost $500,000, and will place orders for mechanical equipment at an early date. McClintock & Craig, 33 Lyman St., Springfield, Mass., are engineers. J. J. Kirkpatrick, Room 9, City Hall, is manager of the department.

Mass., Lanesville—The Cape Ann Granite Co. plans for the rebuilding of the portion of its boiler plant, recently damaged by fire. An official estimate of loss has not been announced.

Mass., North Weymouth — The Edison Electric Illuminating Co., Boston, has superstructure work under way on its new steam-operated electric generating plant on the tidewater, to cost in excess of $650,000.

Mich., Battle Creek—The Water Department is reported to be planning for the installation of electric-operated pumping equipment in connection with a proposed sewerage disposal plant, to cost approximately $500,000. W. W. Brigden is superintendent.

Mich., Owosso—The Walker Candy Co., Muskegon, Mich., contemplates the installation of a boiler plant at its proposed local factory, estimated to cost $200,000. The present factory at Muskegon will be removed to the new location.

Mich., Ramsey—The Castile Mining Co. will soon commence the erection of a new steam-operated power plant. It will cost about $105,000.

Mich., Trenton—The Detroit Edison Co., Detroit, has preliminary plans for the rebuilding of the portion of its local electric power plant, destroyed by fire recently with loss reported at $50,000, including equipment.

Minn., Alexandria — The City Council plans to call for bids during the summer for the construction of a municipal electric power plant to cost about $35,000, for which plans are being prepared by the C. L. Pillsbury Co., 1200 Second Ave., South Minneapolis, Minn., architect and engineer.

Minn., Fergus Falls—The Common Council is arranging a bond issue of $650,000 for the proposed municipal power plant on Hoot Lake, and will have plans prepared at an early date. H. C. Collins is city clerk.

Minn., Luverne—The City Council has preliminary plans under consideration for the erection of a new generating unit at the municipal power station. D. W. Camobell is city clerk.

Mo., Clarence—The North Missouri Power Co., Excelsior Springs, Mo., has acquired the local municipal power plant and contemplates extensions.

Mo., Kansas City—The American Can Co., 120 Broadway, New York, is reported to be planning for the construction of a steam power house at its proposed four-story and basement plant on site recently acquired at Fourteenth and Campbell Sts., estimated to cost close to $500,000. The project is expected to mature early in the summer.

Mo., St. Joseph—The Missouri Rubber Products Co., Kirkpatrick Bldg., is considering the construction of a boiler plant at its proposed local factory at Commercial and Twenty-second Sts., to cost about $400,000, on which work will soon be started.

Mo., Troy—The East Missouri Power Co., Troy, has acquired the local municipal power station and is said to be planning for extensions in the steam and electric departments, including the installation of additional equipment.

Neb., Blair—The Common Council will soon take bids for an oil-operated engine and auxiliary equipment for installation at the municipal power house, estimated to cost about $25,000. C. E. Krause is city clerk.

N. J., Morris Plains—The Commissioner of Institutions and Agencies, State Office Bldg., Trenton, will receive bids until April 17 for one electric-operated pumping unit and auxiliary apparatus for water service at the local state hospital. Burdette G. Lewis, commissioner.

N. Y., Buffalo—The Victor Box & Mill Co., Buffalo, is reported to be planning for the construction of a boiler plant at its proposed mill on site recently acquired at Sumner and West Shore Avenues.

N. Y., Fairport—The Fairport Cold Storage Co. has tentative plans under advisement for the erection of a four-story cold storage plant, estimated to cost in excess of $80,000. J. Bridges, 16 East Ave., is one of the heads of the company.

N. Y., Geneva—The Rochester Ice Cream Co., foot of White Street, Rochester, N. Y., is considering plans for a new ice and refrigerating plant at its proposed local factory on Elm Street, reported to cost close to $90,000.

N. Y., Glens Falls—The Board of Supervisors of Warren County, J. J. Harris in charge, will take bids early in May for a central steam plant for heating service for county buildings. Tooker & Marsh, 101 Park Ave., New York, are architects.

N. Y., Long Island City—Henry Maillard, 368 Fifth Ave., New York, plans for the installation of a boiler house at his proposed chocolate and confectionery plant on Henry St., estimated to cost $750,000. Buchman & Kahn, 49 West Forty-fifth St., New York, are architects.

N. Y., New York—The Merchants Refrigerating Co., 181 Chambers St., will install a cold storage and refrigerating plant in its sixteen-story operating building, 75 x 110 ft., to be erected at 17-25 Moore St., for which a general construction contract has been let to the Turner Construction Co., 244 Madison Ave. It will cost approximately $400,000. John B. Snook Sons, 52 Vesey St., are architects.

N. C., Dallas—The Common Council plans for the installation of electric-operated pumping equipment in connection with a new waterworks system to cost about $45,000. J. P. Hoffman is city clerk.

N. C., Lucama—The Board of City Commissioners has authorized plans for the installation of a municipal electric light and power plant.

N. C., Southport—T. B. Carr, Southport, and Harold M. Prager, Savannah, Ga., plan for the construction of a steam-operated power plant at their proposed local canning factory, estimated to cost $90,000. A company, capitalized at $250,000 is being formed to operate the plant.

N. C., Tryon—The Common Council plans for the installation of electric-operated pumping machinery at the proposed waterworks station, designed for a daily output of 548,000 gals. Harwood Beebe, Spartanburg, S. C., is engineer.

Okla., Cushing — The Common Council has authorized the construction of a pumping plant for the proposed new waterworks station. Bonds for $500,000 have been approved and bids will soon be asked.

Okla., Hinton—The Common Council is perfecting arrangements for a special election to vote bonds for a municipal electric power plant. A city-owned ice-manufacturing plant is also under consideration.

Okla., Oklahoma City—The Zero Ice & Cold Storage Co., 729 West Grand Ave., recently organized, has work in progress on remodeling and improving an existing building, and will install ice-manufacturing and mechanical equipment for a daily output of 30 tons. H. S. Oberman is president and general manager.

Okla., Tulsa—The Boether Co., Denver, Colo., plans for the installation of a steam-operated electric power plant at its proposed local cement mill, consisting of 3,000 kw. turbo-generators and auxiliary equipment, with waste heat utilization system, etc. The entire project will involve $1,500,000. C. D. Nichols is local representative.

Ore., Tillamook—The Common Council plans for the installation of electric-operated pumping equipment in connection with extensions in the municipal waterworks, using water from Fawcett Creek, estimated to cost $50,000.

Pa., Abington—The Board of Education has had plans prepared for the construction of a power house in conjunction with a new manual arts building at the local school. Heacock & Hokanson, 1218 Chestnut St., Philadelphia, are architects.

Pa., Kesery (Elk County)—The Glen Coal & Clay Products Co. plans for the construction of a power house at its proposed local tile and burned clay products plant, estimated to cost close to $90,000.

Pa., Danville—Edward W. Peters, 108 Lower Mulberry St., is planning for the purchase of an oil-operated engine, with capacity of 125 hp., and accessory apparatus.

Pa., Monaca—The Superior Steel Co., Beaver Falls, Pa., recently organized, plans for the construction of a boiler plant at its proposed local steel mill, estimated to cost $95,000. M. P. Simpson, New Brighton, Pa., is president; and Homer H. Swaney, Beaver Falls, treasurer.

Pa., Philadelphia—The Bureau of Water, City Hall, is taking bids until April 16, for the construction of a power house at the Northeast sewerage district disposal works, Wheatsheaf Lane.

R. I., North Smithfield—Bids are being taken by Lockwood Greene & Co., 24 Federal St., Boston, for the Branch River Wool Combing Co. plant at North Smithfield, which includes a boiler plant and pump house. Plant cost estimated at $1,000,000.

S. C., Spartanburg—The Southern Railway Co., Washington, D. C., plans for the construction of a steam-operated power plant at its proposed car and locomotive repair shops at Hayne, near Spartanburg, where tract of land has been acquired. The complete plant will cost $500,000, and will replace the former works at Gadsden, Ala., recently destroyed by fire.

S. C., York—The Common Council contemplates the installation of electric-operated pumping equipment in connection with proposed extensions in the waterworks, estimated to cost $35,000.

S. D., Salem—The Common Council contemplates the installation of a sanitary sewerage system, with electric-operated pumping station, estimated to cost $25,000.

Tex., Dallas—The Board of Works plans for the installation of a pumping plant in connection with the proposed waterworks reservoir and supply station on the Elm Fork of the Trinity River, for which an initial fund of $2,000,000 is available. Nagle & Thompson, 2003½ Main St., are consulting engineers.

Tex., El Paso—The El Paso Cotton Mill Co. will soon begin the erection of a steam-operated power house at its proposed local plant, estimated to cost $200,000. A. P. Coles is president.

Tex., Ennis—The Common Council has tentative plans under advisement for the construction of a municipal electric power plant. C. A. Gilley is a member of the local committee in charge.

Tex., Fort Worth—The Burton Concrete Co., recently formed, plans for the construction of a steam-operated power house at its proposed local plant, to cost about $55,000. L. L. Burton is president.

Tex., Houston—The Massey Mfg. Co. is reported to be planning for the rebuilding of the portion of its woodworking plant and boiler house at Railroad Ave. and Yale St., recently destroyed by fire with loss of about $70,000.

Tex., Marble Falls—The Marble Falls Textile Mills plan for the construction of a power house at their proposed new plant, estimated to cost $500,000.

Tex., Mexia—The Western Agricultural Chemical Co. plans for the construction of a boiler plant at its proposed local fertilizer mill, estimated to cost close to $100,000. V. G. Dawson is construction engineer.

Tex., Pearsall—The Texas Central Power Co., San Antonio, plans for extensions and alterations at its local ice-manufacturing plant, including the installation of additional equipment.

Tex., San Antonio—The Methodist Episcopal Church Association, W. H. Chambers, San Antonio, in charge, plans for the construction of a steam-operated electric power plant for service at the proposed local encampment. A pumping plant for water service is also under consideration.

Va., Lynchburg—The Diamond Ice Co. will enlarge its cold storage plant and install additional equipment, with cost estimated at $35,000.

Wash., Kelso—The City Council plans for the installation of electric-operated pumping equipment in connection with proposed extensions and improvements in the municipal waterworks, estimated to cost $250,000. It is proposed to issue bonds for the work.

Wash., Lynden — The Common Council plans for the installation of electric-operated pumping equipment in connection with extensions in the municipal waterworks, estimated to cost $32,000. Bonds have been voted.

Wash., Seattle—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until April 22, for one duplex pump and one set of spare parts for the Puget Sound navy yard, as per Schedule 2033.

Wash., Usk—R. L. Dudley, Usk, is planning for the installation of an electric-operated pumping plant in connection with a proposed waterworks for local service, estimated to cost $45,000. Application for permission to use water has been made to the State. A company will be formed to operate the utility.

Wash., Wenatchee—The Whitestone Irrigation District is said to be planning for the construction of a series of electric-operated pumping plants in connection with the installation of an irrigation works to cost $900,000, with equipment. Bonds have been approved.

W. Va., Charleston—E. H. Morford & Co. are planning for the purchase of a slide valve engine, with capacity of 100 hp., and auxiliary power apparatus.

W. Va., Martinsburg—The City Council will soon call for bids for a pumping plant in connection with the proposed extensions in the municipal waterworks, to cost about $100,000.

W. Va., Pratt—The Montgomery Utilities Co., Charleston, W. Va., George M. Eckley in charge, has plans for the installation of a steam-operated power plant for local commercial service.

W. Va., Romney—The Hampshire Cold Storage Co., recently organized, is planning for the construction of a one-story cold storage plant on local site, estimated to cost $50,000. J. D. Christopher and Paul Williams, Romney, head the company.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

The price situation is much weaker than it was a month ago. The downward trend in non-ferrous metals was the most important move during the month. Prices of belting, packing, pipe covering and refractories, however, are firm at present levels. A few minor advances occurred in power-plant supplies, such as a rise of ¾c. in wiping clothes in New York and 4c. per gal. in linseed oil in Cleveland. Conservatism marks all purchasing of supplies despite the fact that neither dealers' nor consumers' reserve stocks are large.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled	61c. per ft.
Common, 2½-in., 3-ply — $1.00 per ft. list less	40%

Air—Best grade

¾-in., per ft. — 3-ply — $0.36	4 ply — $0.44½	

Steam—Discounts from List

First grade — 30%	Second grade — 40%	Third grade — 40–5%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Best grade	50%	Second grade	50–5%

LEATHER BELTING—List price, 2c. per sq. in., per ply.

Grade	Discount from list
Medium	40–2½%
Heavy	30–5%

RAWHIDE LACING { For cut, best grade, 45–5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45–5%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ½ in.	$0.90
Asbestos for high-pressure steam, ½ in.	1.70
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@ $2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.64 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	14@21	20.00	14.00
Colored	9@12½	17.00	10.50

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	16.00	16.00
New York	11.75	
Cleveland	$36.00 per M.	$52.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.95	$1.08	$0.94

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	15.00	14.25	16.50	15.75
White	15.00	14.25	15.00	14.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	50%	60%	60%
Tinned	50%	60%	4½c. per lb. net

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York	$4.40	Chicago	$3.75	Pittsburgh	$2.75

Boiler rivets, same sizes:

New York	$4.50	Chicago	$3.85	Pittsburgh	$3.00

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$50@55
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	27@32
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	31@36
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.2[illegible]
Silica brick: Mt. Union, Pa.	per M	42.00@43.50
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	41@48
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	42@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	42@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	36@43
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	37@39
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	37@39
Chrome ore crude, 40@ 50%	net ton	18.00@23.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	60.00	64.00	48@52
(35% tin)	28.00	21.50	22@25

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.40	$3.90	$4.30
Flats, square and hexagons, per 100 lb. base	4.90	4.40	4.80

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
4	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
1	.20	.25	.21
1¼	.23	.29	.23
1½	.24	.33	.28
2¼	.....	.....	.....
2	.30	.41	.32
2¼	.32	.47	.35
3¼	.34	.51	.37
2	.43	.64	.47

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2¼ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 44.50 (net)	$ 65.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	35%	20%
Coils to 1,000 ft	45%	25%
1,000 to 5,000 ft	50%	30%
5,000 ft. and over	55%	35%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$61.10	$66.16	$9.90	$11.03	$5.74	$6.16
¾	79.20	84.95	13.00	14.49	8.18	8.78
1	112.06	122.19	19.26	21.46	10.65	11.42
1¼	151.62	165.31	25.65	28.33	14.76	15.78
1½	181.28	197.67	34.19	37.77	18.23	19.47
2	248.90	265.94	62.70	69.24	24.29	25.97
2½	385.50	420.48	102.58	111.33	34.71	37.10
3	504.29	548.81	273.40	302.12	51.66	55.63
3½	633.86	688.65	604.03	667.15	69.41	74.19
4	772.62	838.59	697.06	770.99	86.76	92.73

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.47	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$22.00
No. 16 cotton reinforced heavy	25.50
No. 18 cotton reinforced light	19.00
No. 16 cotton reinforced light	21.50
No. 18 cotton Canvasite cord	16.50
No. 16 cotton Canvasite cord	18.75

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500)	$2 70
0–30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.30	$0.35	120	50	$0.45	$0.45	60
15	.30	.35	120	75	.50	.55	60
25	.30	.35	120	100	.60	.65	24
40	.30	.35	120	150	.75	.80	24
50	.30	.35	120	200	1.00	1.10	24
60	.35	.40	120	300	1.60	1.70	24
				500	2.35	2.50	12
				750	3.75	3.95	8
				1,000	4.00	4.25	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $75.00 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Composition—2 Pc. Plug—Composition	0.8½

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York,

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 7.72	$10.48	$13.78	$19.68
12	10.43	13.50	15.25	25.79
10	13.97	17.52	19.73	31.95
8	19.18	22.91	24.53	42.99
6	.....	.....	36.07	.....
4	.....	.....	49.06	.....
2	.....	.....	71 54	.....
1	.....	.....	94.27	.....
0	.....	.....	125.60	.....
00	.....	.....	145.50	.....
000	.....	.....	175.25	.....
0000	.....	.....	208.35	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	½ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0 55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%